Guidobaldo dal Monte's Mechanics in Context

A Research on the Connections between his Mechanical Work and his Biography and Environment

Martin Frank

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Supervisors:
Prof. Dr. Pier Daniele Napolitani, Università di Pisa
Prof. Dr. Carlo Maccagni, Università di Genova
Prof. Dr. Jürgen Renn, Max-Planck-Institut für Wissenschaftsgeschichte Berlin

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Meinen
Eltern

Contents

Guidobaldo dal Monte and the *Studia guidobaldiana*[1]

Guidobaldo dal Monte (1545-1607) was one of the most important mathematicians of sixteenth-century Italy. His vast mathematical interests, extending from geometry and arithmetic over astronomy, musics and gnomonics to perspective and mechanics, manifested themselves in a prolific scientific activity, producing a notable number of printed works and manuscripts. The list of his interlocutors and correspondents, including many of the major exponents of sixteenth-century mathematics like Baldi, Barozzi, Clavius, Commandino, Magini and last but not least Galileo, evidences his centrality in the scientific debate of those times.
Two aspects of his scientific activity seem particularly noteworthy: firstly, his fundamental contributions particularly to mechanics and perspective, respectively with the works *Mechanicorum Liber* (1579) and *Perspectivae Libri sex* (1600). Secondly, Guidobaldo's realisation of young Galileo's scientific talent and his decisive support concerning the latter's appointments as professor at the universities of Pisa and Padua.

Despite of Guidobaldo's importance for sixteenth-century mathematics and its subsequent evolution, his scientific work has been ignored for a long time by historiography of science. Among the reasons of this regrettable state there were exterior factors like Pierre Duhem's abrasive and unfounded criticism of Guidobaldo's mechanics as "sometimes in error, always mediocre" (*Origines de la Statique*, 1905). Also the Marchigian mathematician's dense and sometimes meandering writing style, moreover in Latin, requiring the reader's perseverance, surely does not constitute a encouraging condition for approaching studies on his writings. The scarce interest towards his work was paralleled by the absence of researches on his biography: nearly the whole information on his life and environment stemmed from seventeenth- or eighteenth-century sources, often resembling eulogies more than objective narrations of facts, whose reliability thus is unclear.

[1] All scientific contributions cited in the present introduction are listed in the bibliography. For its introductory character we confine ourselves here, in contrast to the following chapters, to the exclusive citation of the title and year of the respective contribution.

The last decade has shown a pleasant rethinking process in regard of Guidobaldo's mathematical work, as the following short selection of the conspicuous number of recent studies shows: J. Renn, P. Damerow, *et alii* have analysed an important aspect of Guidobaldo's collaboration with Galileo (*Hunting the White Elephant*, 1998), D. Bertoloni Meli has dedicated the first chapter of his work on the transformation of mechanics in the seventeenth century (*Thinking with Objects*, 2006) to central elements of Guidobaldo's mechanics, and K. Andersen has proved the fundamental importance of Guidobaldo's contributions to perspective (*The Geometry of an Art*, 2007). The reawakened interest towards his scientific work is moreover reflected by the organisation of an international conference on Guidobaldo dal Monte in 2007 (Urbino, Mombaroccio June 15th-16th).
This rethinking was accompanied and facilitated by two ample studies about Guidobaldo's Italian and specific regional scientific environment: P.L. Rose analysed the rediscovery of Greek mathematics in *The Italian Renaissance of Mathematics* (1975), dedicating three chapters to Commandino, Guidobaldo and Baldi, the main exponents of the "School of Urbino". E. Gamba and V.Montebelli attended with *Le Scienze a Urbino nel tardo Rinascimento* (1988) to the study of the scientific-technical environment of the Duchy of Urbino in the period from about 1550 until 1650.
The increased interest in Guidobaldo's work is integrated in a broader framework of recent studies on other exponents of this environment with its important preparations for the scientific revolution: A. Marr's investigation on Muzio Oddi's mathematical culture (*Between Raphael and Galileo: Mutio Oddi and the Mathematical Culture of Late Renaissance Italy*, 2011) and the studies on Bernardino Baldi's mechanical work conducted by A. Becchi (*Q. XVI. Leonardo, Galileo e il caso Baldi: Magonza, 26 marzo 1621*, 2004) and by E. Nenci (*Bernardino Baldi's* In mechanica Aristotelis problemata exercitationes, 2010).

Topic and aim of the present Ph.D.-thesis

The focus of this Ph.D.-thesis, which intends to give a contribution to the reawakened studies on his scientific work, is laid on Guidobaldo's occupation with mechanics. In fact, despite of the increased number of studies on his mechanics in the last years, we still are far from having achieved a full comprehension of Guidobaldo's complex scientific activity. Substantially three factors could be identified that seem to obstacle the achievement of this goal: one of the major problems appears to be the lack of studies on Guidobaldo's mechanics considered as a whole; most of the contributions prefer the analysis of single works of the Marchigian mathematician, or even partial aspects of them. This restriction, however, makes it difficult to carve out the general characteristics of Guidobaldo's mechanics, sometimes even leading to a distortion of the relevance constituted by the respective topics; moreover, a similar approach does not seem appropriate to analyse the possible development of Guidobaldo's ideas and conception of mechanics over the circa thirty years of his scientific activity.

Another fundamental problem regards the general approach to Guidobaldo's work: his mechanical theory has often been studied not in order to comprehend it itself, but for other purposes: in this regard, the lengthy dominating custom in history of mechanics of the sixteenth century to evaluate its exponents' works in the light and as comparison of/to Galileo's achievements has not been beneficial for the *studia guidobaldiana*.[1] A comparable situation can be recognised also for other scholars like Benedetti.[2] In effect, it is clear that a perspective converging to Galileo's work tends to underestimate the role of the scholars before him.
A further example of an instrumentalising approach to Guidobaldo's mechanics is Duhem's interpretation of the evolution of mechanics, regarding the Marchigian mathematician as mediocre scholar who would have impeded the diffusion of the innovative and fruitful mechanical theory of Jordanus Nemorarius.
Possibly the most relevant obstacle to a full comprehension of Guidobaldo's scientific work, however, is the substantial lack of information about the environment that constituted the framework in which Guidobaldo's work found its realisation. Despite of the aforesaid, excellent studies of Rose (1975) and Gamba/Montebelli (1988), many important aspects of Guidobaldo's interaction with his scientific and technical ambiance still were unknown when the works on the present thesis had been begun.

Given this situation, a two-pronged approach has been chosen for the present thesis: on the one hand, biographical studies on Guidobaldo and his interlocutors should reduce the knowledge gaps about his life and environment which formed the important context of his work. The other main pillar is constituted by the analysis of his most important writings and of the development of two crucial aspects of his mechanics as a whole. Clearly, the researches on these two levels were strictly connected with each other: the information about Guidobaldo's *milieu* and scientific-technical interactions permitted to apply new readings to his scientific work. And on the contrary, the analysis of his work was necessary to comprehend certain discussions in his environment. In fact, the present thesis

[1] Cf. K. Andersen, *Geometry of an Art*, pp. 237-238: "When Guidobaldo is mentioned, it is most often in connection with Galileo, to whom he was an important patron and friend. The two scientists discussed many of Galileo's ideas and conducted experiments together (Rose 1974). Guidobaldo does, however, deserve to be better known for his own accomplishments, especially for his contributions to the mathematization of the foundation of perspective constructions."

[2] Cf. E. Giusti, *Gli scritti* De Motu *di G.B. Benedetti*, pp. 52/53: "Questo carattere autonomo della ricerca benedettiana ha fatto sì che gli studi, pur abbastanza numerosi dopo la riscoperta di Benedetti nel secolo scorso (...), vertessero soprattutto sull'influenza delle sue teorie sul giovane Galileo, a scapito di una ricostruzione del pensiero dello scienziato veneziano, della cui opera manca tuttora una soddisfacente analisi scientifica. (...) Ci proponiamo invece (..) di esaminare in dettaglio la struttura e l'evoluzione delle idee di Benedetti relative al moto dei gravi; una ricerca al termine della quale, crediamo, esse acquisteranno uno spessore diverso da quanto, appiattendole sulle ben più avanzate speculazioni galileiane, molti studi ci hanno finora presentato."

intends to suggest the following approach to studies on history of mechanics: as particularly chapter I of Part B proves, intense studies on a scholar's biography and scientific environment are necessary for the comprehension of his work and should consequently be combined with the actual studies on his scientific work. In this context, I wish to thank the professors Napolitani and Maccagni for their constant support in this project.

The first step to a better comprehension of Guidobaldo's scientific environment was constituted by the analysis of his correspondence. In this regard, we would like to thank prof. Enrico Gamba most sincerely for placing at our disposal the transcription of the part of Guidobaldo's letters conserved at Pesaro and Urbino. After the procuration of the other (known) component of his extant correspondence, scattered all over Europe at Oxford, Paris, Milan ecc. – the publication of his correspondence is forthcoming – a careful reading of the letters furnished the first reference points both about the scientific topics Guidobaldo was mostly interested in as well as about his interlocutors and collaborators. On the basis of these studies, we could lead targeted researches over several months in various Italian archives and libraries (mainly in the Biblioteca Oliveriana at Pesaro, the National Archive at Florence, the Biblioteca Universitaria at Urbino and the Biblioteca Ambrosiana at Milan), that furnished ample documentary material about Guidobaldo's biography and scientific environment, exposed in the Appendixes I and II (respectively pp. 415-602 and 604-698). These researches would not have been possible in this form without the collaboration with the Max-Planck-Institut für Wissenschaftsgeschichte, wherefore we would like to sincerely thank its director Jürgen Renn, the head of the library Urs Schöpflin and its staff.[1] On this basis, it was possible to reconstruct relevant parts of Guidobaldo's biography (cf. Part A, chapter I, pp. 20-66), and delineate some general traits of the courtly and of the scientific-technical environment which Guidobaldo frequented (cf. Part A, chapter II, pp. 67-81).

Against the background of these biographical researches, Guidobaldo's principal mechanical works have been analysed, the results being exposed in the successive chapters of Part A: after a short overview of the various, differing mechanical traditions and key elements of the dominating Aristotelian natural philosophy in chapter III (pp. 82-105), the chapters IV-VI deal with the *Mechanicorum Liber* (pp. 106-171), the *Paraphrasis* (pp. 172-212) and the mechanical pages of the manuscript *Meditatiunculae* (pp. 213-261). The studies on his biography and on the scientific debates in his environment contributed to a better understanding of these works and sometimes even led to a new reading of certain elements of them. Correspondingly, each of these chapters is introduced by a section delineating the context and the conditions in which the respective writing was created.

[1] A part of these materials have been scanned and are accessible at http://echo.mpiwg-berlin.mpg.de/content/mpiwglib/pesaro.

Part B of the present thesis is dedicated to the analysis of two fundamental and particularly important elements of Guidobaldo's mechanics as a whole. In fact, both the researches on his scientific environment and its key topics, as well as the analysis of his works revealed a coherency of his mechanical work that maybe could not be expected before: on the one hand, his treatment of the isostatic balance, connected with the discovery of the indifferent equilibrium, turned out to have been a topic of fundamental importance during his whole scientific activity (cf. Part B, chapter I; pp. 263-330). There is still another reason why this topic deserved an in-depth study: it is a revealing and emblematic example, how the the lack of studies on Guidobaldo's biography entailed distorted interpretations of his mechanics.[1]
Chapter II, in contrast, analyses Guidobaldo's attempts in various occasions to treat and to formalise the concept of *proto-moment* which was one of the most challenging problems of the recovery of the Archimedean mechanics (cf. Part B, chapter II; pp. 331-390), whose solution constituted an important step in the process of establishing mathematical models of the physical reality (cf. P. Galuzzi's *Momento. Studi galileiani*, 1979).

Yet, also scholars who do not particularly occupy with Guidobaldo's mechanics might find useful information in the present thesis: on the one hand, the documents on his scientific-technical environment will facilitate the study of his work concerning other mathematical branches like astronomy or gnomonics. In this context, in-depth analyses of Guidobaldo's contributions to these two disciplines

[1] In fact, Guidobaldo's treatment of the isostatic balance is strictly connected with his harsh critique and rejection of Jordanus's mechanics. Now, his general attitude towards medieval mechanics, including the rejection of Jordanus's correct inclined plane solution, seems to have been systematically misinterpreted. For example, cf. P.L. Rose, *The Italian Renaissance of Mathematics*, p. 233: "Guidobaldo, however, refused to countenance the use of *insensibilia* in mechanics, because they were not susceptible of precise mathematical definition. (...) Guidobaldo denounced Jordanus, Cardano and Tartaglia for assuming that the lines of descent of heavy bodies were parallel rather than convergent to the centre of the earth. (...) The answer of both Tartaglia and Galileo (..) was that, at a great distance from the centre, the difference between the parallel and convergent lines of descent was insensible and negligible. This extreme concern for precision led Guidobaldo to reject the valid inclined-plane theorem of Jordanus in favour of the erroneous theorem of Pappus." See moreover Drake&Drabkin, *Mechanics in Sixteenth-Century Italy*, p. 46: "The reaction of Guido Ubaldo against the medieval pattern, after he had studied the ancient mathematicians under Commandino, was so great that he actually rejected the correct theorem of Jordanus on inclined plane equilibrium and adopted the incorrect theorem of Pappus in its place. This misplaced homage to the ancients and to the idea of absolute mathematical rigor in questions of mechanics blinded Guido Ubaldo to the possibility of important advances in the science that he would other wise have been quite capable of making."
On the contrary, as chapter I of Part B reveals, Guidobaldo's rejection of Jordanus's theory was *not* a question of parallelism of convergence of the lines of action, but, much more profoundly, the rejection of his key principle *gravitas secundum situm*, with which Jordanus "proved" the non-existence of indifferent equilibrium on the isostatic balance; this topic was, in contrast, a cornerstone of Guidobaldo's mechanics.

seem to be still missing and would be useful for a full understanding of his complex scientific activity, the status of these studies laying behind the state of the art regarding his work in perspective and mechanics.
On the other hand, the here presented results may serve for further researches on the scientific-technical environment at Urbino in late Renaissance. Its importance and contributions for the birth of modern science contrast with the little attention paid to it.[1] This topic is closely connected with another, more general problem: that of the role of the Renaissance courts and their scientific-technical environments for the genesis of modern science. In this context, the recent constitution of the international project "Archimede nel Rinascimento" is a pleasant event,[2] its goal being exactly a better comprehension of the transformation of ancient knowledge in modern science.
The part "Conclusions, Interpretations, Perspectives" (pp. 392-399) summarises the results exposed in the precedent Parts A and B and presents the conclusions deriving from the studies undertaken in the context of the present thesis.

Acknowledgements/Ringraziamenti/Danksagungen

I wish to express my gratitude to everybody who has supported me in the realisation of this doctoral thesis.
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Prof. Jürgen Renns Ratschläge waren von großer Hilfe und Wichtigkeit. Die mehrmaligen Aufenthalte am Max-Planck-Institut trugen mit aufschlussreichen

[1] It is not necessary to underline the contributions of the Urbinate ambiance for the preparation of the scientific revolution in the seventeenth century, for example by editing fundamental texts of Greek mathematics. Also its influence on Galileo was notable: he read the works of Commandino; he got encouraged and supported by Guidobaldo; and another important scientific interlocutor of Galileo was Jacopo Mazzoni, on his part strictly connected with the Duchy of Urbino and its intellectual exponents.

[2] The constitutive parts of this research project are the University of Pisa; the Max-Planck-Institut für Wissenschaftsgeschichte Berlin; the University of Urbino; Centre Jean Pépin UPR 76 CNRS; UMR 8630 Syrte Observatoire CNRS; Osaka Prefecture University, Centre d'Études Supérieures de la Renaissance Tours; Centro Internazionale di Studi Urbino e la Prospettiva; Indiana University; Biblioteca Leonardiana di Vinci, Biblioteca Oliveriana Pesaro. Cf. http://www.urbinoelaprospettiva.it/archimede/index.asp.

Diskussionen maßgeblich zur Formgebung dieser Dissertation bei. Fundamental war auch die großzügige finanzielle Unterstützung der Forschungsmissionen von seiten des MPIWG, die sonst wohl nicht möglich gewesen wären.
In diesem Zusammenhang möchte ich auch besonders dem Direktor der MPIWG-Bibliothek Urs Schöpflin und seinen Mitarbeitern danken. Ihre freundliche Unterstützung während des ersten Pesaro-Aufenthaltes und weiterer Stationen waren eine wichtige Grundlage für das Gelingen der Digitalisierungskampagnen. Auch Antonio Becchi, Elio Nenci, Pietro Omodeo und Matteo Valleriani möchte ich meinen Dank aussprechen für ihre interessanten Anregungen.
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In questa occasione vorrei ringraziare il direttore della Biblioteca Oliveriana Marcello di Bella e il personale della biblioteca per l'accoglienza e la competenza dimostrata durante il mio soggiorno di studio, durato alcuni mesi. Sono particolarmente grato a Luca Cangini per le preziose indicazioni che mi ha fornito. Inoltre, vorrei esprimere i miei ringraziamenti anche al dott. Federico Marcucci, responsabile del Fondo Antico della Biblioteca Universitaria di Urbino.
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Dankbar bin ich meinen Freunden für ihr Unterstützung und ihren moralischen Beistand, vor allem in den letzten, besonders arbeitsintensiven Monaten vor der Abgabe. Ringrazio infine tutti gli amici di Pisa perché, al di là del lavoro, hanno contribuito a rendere il mio soggiorno in Italia un'esperienza preziosa e indimenticabile.
Schließlich gilt besonderer Dank meinen Eltern, die mich immer und in jeder Hinsicht unterstützt haben, und meinen Brüdern Rupert und Korbinian, für die Englischkorrekturen und Hilfen in informatischer Hinsicht.

Sources and their citation

In accordance to its focus, the present doctoral thesis contains numerous citations and transcriptions deriving from a conspicuous number of sources. In order to guarantee a high degree of uniformity and readability of them, transcription criteria have been elaborated with prof. Alfredo Stussi – to whom we want to thank warmly in this occasion – exposed on pages 415-416, at the beginning of Appendix I. For the sake of brevity, in the references the following abbreviations are used to indicate the respective libraries and archives:

ACM: Archivio Comunale Mombaroccio
ACP: Archivio Carpegna
APUG: Archivio Pontificia Universita Gregoriana, Roma
ASCP: Archivio Storico Comunale Pesaro; integrated in BOP;
ASF: Archivio di Stato Firenze
ASG: Archivio di Stato Gubbio
ASM: Archivio di Stato Mantova
ASP: Archivio di Stato Pesaro
BAM: Biblioteca Ambrosiana, Milano
BCS: Biblioteca Comunale, Siena
BCF: Biblioteca Comunale, Forli
BCM: Biblioteca Cardinal Maffi, Pisa
BLO: Bodleian Library, Oxford
BNCF: Biblioteca Nazionale Centrale, Firenze
BNMV: Biblioteca Nazionale Marciana, Venezia
BNP: Bibliothèque Nationale de France, Paris
BOP: Biblioteca Oliveriana, Pesaro
BUU: Biblioteca Universitaria, Urbino
UCLA: University of California Library, Los Angeles

Part A

Guidobaldo's mechanics in the context of his life and environment

Chapter I

Reconstruction and contextualisation of Guidobaldo's biography

The core of the present chapter, section I.2, exposes a reconstruction of Guidobaldo dal Monte's biography. The section before, I.1, contains hints at the general socio-political framework in which the life of the Marchigian mathematician was integrated and consequently facilitates the comprehension of I.2. The last section, I.3, adumbrates the ulterior developments of Guidobaldo's (especially scientific) patrimony and family after his death, until its extinction few decades later.

I.1 The dal Monte family in the Duchy of Urbino

The Duchy of Urbino under Guidobaldo II and Francesco Maria II

> *La corte del Duca e di tutta quella casa, come per una consuetudine, è stata sempre onorevole, percioché in ogni tempo, e nell'armi e nelle lettere, ella ha avuto de' più segnalati uomini d'Italia.*
>
> The Venetian ambassador Badoer in his report about the Urbinate court (1547).

The Duchy of Urbino, despite of being one of the minor states in sixteenth century Italy, had gained some importance in the Italian political power structure: its Dukes, first the Montefeltro (1443-1508), then the della Rovere (1508-1631), were noted for their military skill and were, thus, successively engaged as generals of major Italian and European states like the Venetian Republic, the Pontifical State or the Spanish Kingdom.

Another characteristic trait of the Urbinate court, besides its accent on warfare, was its rich cultural life. The ducal library was considered as one of the richest of all Italy and the court hosted throughout the fifteenth and sixteenth-century outstanding characters of the literary and artistic world, as Leon Battista Alberti, Piero della Francesca, Francesco di Giorgio Martini, Paul of Middelburg, Raffaello Sanzio, Donato Bramante, Federico Barocci or Torquato Tasso.

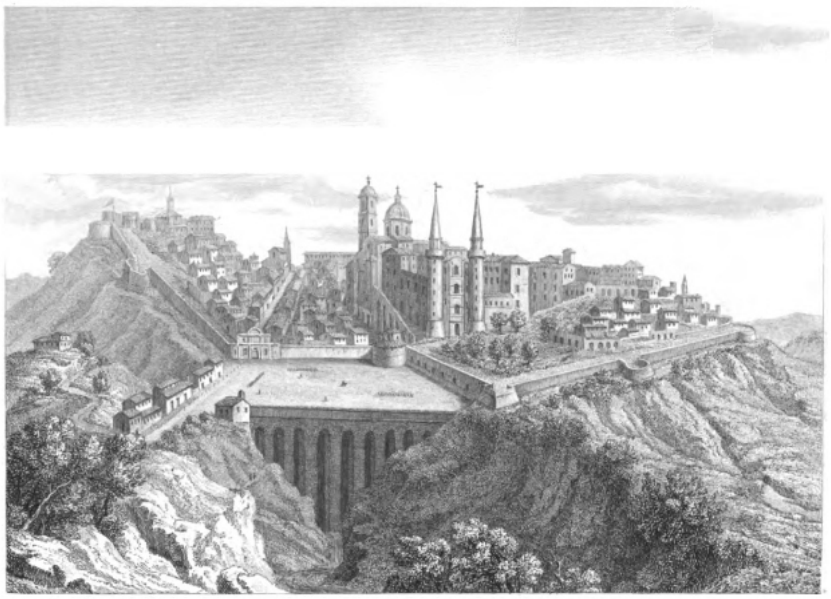

Figure I.1: A panorama of Urbino.

The Duchy in the period we deal with was reigned by Guidobaldo II della Rovere and his son Francesco Maria II.[1] Like his ancestors, the former was an important *condottiere*: in 1546, he became *Governatore delle armi venete* of the Venetian republic, in 1553 "captain-general of the Church" and five years later he was taken in service by Philip II.[2] However, as the military-political situation in Italy was settling down in the second half of the sixteenth century – after a century of battles and invasions – the Duke had increasing difficulties to conclude favourable contracts in the quality of military captain and to assure, thus, sources of revenue to his Duchy that had few other relevant means of income. These problems, coupled with the propensity of an extravagant courtly life, at

[1]Guidobaldo II (1517-1574) reigned from 1538 until his death. His son Francesco Maria II (1549-1631) was the last Duke of Urbino, as the Duchy, without male heirs to the throne, devolved to the Pontifical State.

[2]The fundamental study on the history of the Duchy is J. Dennistoun, *Memoirs of the Dukes of Urbino*, vols. 3, London, Longman, 1851. An Italian annotated translation, *Memorie dei Duchi di Urbino*, has been recently edited by G. Nonni, Urbino, Quattroventi, 2010. Relevant information is contained also in F. Ugolini, *Storia dei Conti e Duchi d'Urbino*, 2 vols., Firenze, Grazzini&Giannini, 1869.

least towards the end of Guidobaldo II's regency,[1] lead to an extremely difficult economical situation of the Duchy at the accession to the throne by Francesco Maria II in 1574.[2]

With the new Duke, many things changed in the Duchy: the necessity to balance the budget entailed a severe policy of austerity; also the life at court must have changed profoundly with the transition from the cordial and generous (though sometimes despotic) Guidobaldo II to his rather solitary, melancholic and diffident son.[3] The most drastic consequences for the Duchy, though, ultimately derived from Francesco Maria II's failed marriage with Lucrezia d'Este:[4] after the marriage in 1571, the couple separated shortly afterwards and consequently remained childless. So, until Lucrezia's death in 1598, the Duke did not have heirs, which fanned the subjects' fear of a possible devolution of the Duchy to the Pontifical State which, in those times, pursued a policy of reincorporating its feuds.[5] He was urged by his subjects to remarry in the same year, with his cousin Livia della Rovere, who, in 1605, finally bore a male heir, Federico Ubaldo. Yet, the hopes to have prevented the devolution of the Duchy were in vain ultimately, for the young successor died already in 1623. Inevitably, the Duchy then passed, after the death of Francesco Maria II in 1631, under the control of the Pontifical State and thus ceased to exist after nearly two hundred years as independent political entity.

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[1] It is the Venetian ambassador Mocigeno that reports this (1571): "Vive Sua Eccellenza <Duca Guidobaldo II> assai allegramente, dandosi piacere con i suoi gentiluomini, e con quelli, li quali sono continuamente appresso la sua persona e pochissima parte del giorno si allontanano da lei (...) Spende Sua Eccellenza molto largamente, ed oltre il trattenere un'onoratissima corte, (...) vuole alloggiare tutti i personaggi che passano per il Stato suo, il numero de' quali alla fine dell'anno si trova esser grandissimo. Dona a' suoi servitori e, quando ha preso la protezione e l'amicizia d'una persona, non cessa mai di accarezzarla e magnificarla, tanto che molto volentieri ognuno concorre a quella corte." Ambassador F. Badoer, already in 1547 had hinted at his generosity, with a propensity to wastefulness: Guidobaldo II had spent, in just one day of the funerals of his wife, a fourth (!) of the annual revenues of the Duchy, cf. Appendix II, I.1.

[2] The Venetian ambassador Matteo Zane (1575) reported: "Ha lasciato il Duca Guido Ubaldo intorno 150.000 scudi di debiti a diversi particolari con qualche interesse sopra, ma a l'incontro ha lasciato delle gioie e una ricca guardaroba d'addobamenti del palazzo. (...)"

[3] At least, this is what historiographers report: for example, cf. L. Firpo, *Lo Stato ideale della Controriforma. Ludovico Agostini*, Bari, Laterza, 1957, p. 112: "Tutta un'età moriva con <Guidobaldo II>, energico e dispotico, gaudente e fastoso Signore di stampo rinascimentale, e un'età nuova sorgeva anche nel piccolo Ducato adriatico sotto il chiuso e malinconico successore <Francesco Maria II> (...). Ebbe ingegno precoce, carattere serio e riflessivo, educazione severa; punto amato dal padre, crebbe diffidente, scontroso, incline alla solitudine; <che, dopo il suo soggiorno biennale alla corte spagnola> si imbevve di spagnolesco umore e dopo tre anni ne tornò peggiorato di malinconico in tetro e altezzoso". Undoubtedly, though, his regency had also positive aspects: his sense of duty in administrative questions was more pronounced than his father's and he did not burden his subjects with high taxes as in contrast Guidobaldo II did.

[4] Lucrezia d'Este was the sister of the last Duke of Ferrara Alfonso II.

[5] So, the Duchy of Ferrara devolved to the Pontifical State in 1598 under Pope Clemens VIII, for the lack of legitimate heirs of Alfonso II d'Este.

The rise of Guidobaldo's family at Pesaro under Ranieri dal Monte

O quanti Cavalier, ch'l mondo bello
Fanno al lor valor, che seco adduce!
Ranier dal Monte, e Montin suo fratello
Io veggio appresso al glorioso Duce
Il conte d'Orcian Pier Bonarella
Ch'or ad Ancona dà splendore e luce
E quel di Montebello, e altri Conti
Tutti d'opere d'amore veloci e pronti.

Bernardo Tasso, *Amadigi*, cap. 100.

The Marchesi del Monte Santa Maria constituted a family of notable importance in Renaissance Italy, whose branches spread out in Perugia, Florence, Ancona and many other Italian cities.[1] Around the year 1527, Ranieri dal Monte (1516-1587)[2], Guidobaldo's father, was sent to the Urbinate court – where also his brother Montino stayed – to become donzel of the prince and future Duke Guidobaldo II.[3] In the successive years, he apparently came to be one of his closest intimates and ministers, as we can deduce from his tasks and appointments: he became chief of the Duke's life guard, was nominated Count of Monte Baroccio, was allowed to marry his first born son off to an illegitimate daughter of the Duke, was appointed *Governatore* of Pesaro,[4] and, moreover, he was made general of

[1]For further information, cf. P. Litta, *Famiglie celebri italiane*, Torino, Basadonna, 1819-1864; U. Barberi, *I marchesi Bourbon del Monte S. Maria di Petrella e di Sorbello: notizie storico-genealogiche sulla casa fino ai giorni nostri*, and *L'archivio gentilizio dei Marchesi Bourbon del Monte di Sorbello a Perugia* (both Città di Castello, 1943). The family is also called "Bourbon del Monte", as it is said to stem from the House of Bourbon.

[2]Appendix II, I.2 offers a more detailed account on Ranieri's life as we can expose here.

[3]It is BOP, ms 758 that testifies this fact: "Il S.r Gironimo de Marchesi dal Monte, allora Marchese dal Monte, (...) mandò il S.r Raniero di età di undoci anni al servizio del suddetto Sig. Duca Guidubaldo per suo paggio nel quale servizio fu così grato a S.E. che cresciuto negl'anni maturi fu continuamente da quella portato inanzi per tutti i gradi maggiori della corte e dello Stato perché nella corte lo onorò dei più principali titoli e dello Stato gli diede tutte quelle cariche che più erano importanti."

[4]Cf. D. Atanagi, *Lettere facete et piacevoli di diversi grandi huomini et chiari ingegni*, Venezia, Bolognino Zaltieri, 1561; cf. its dedicatory letter: "Et oltre a ciò avete meritato che S. Eccell. in riconoscimento di tanta servitù, et di tante vostre virtù, oltre all'avervi deputato già Capitano de le sue Lance Spezzate, et Generale delle battaglie del suo stato, et in particolare Governatore della città di Pesaro (...)." A confirm of this fact seems to be contained in a letter from Ranieri to Duke Francesco Maria II of July 16th 1584 (ASF, Ducato di Urbino, Classe I, 259, fol. 159r.), in connection of Ranieri's and Guidobaldo's involvement in the arrest of Count Giovanni de' Tommasi: the wording "we will not leave to attend to the city <Pesaro> with the reliability and honesty (...) to which we are obliged by the service to Your Highness" suggests that administrative or executive tasks at Pesaro were no isolated case for Ranieri and Guidobaldo; see Appendix I, I.3.4. Another clue in this direction is contained in the *Storia di Pesaro* by Girolamo Ardizi (BOP, ms 377), concerning, though, a later period (summer 1584;

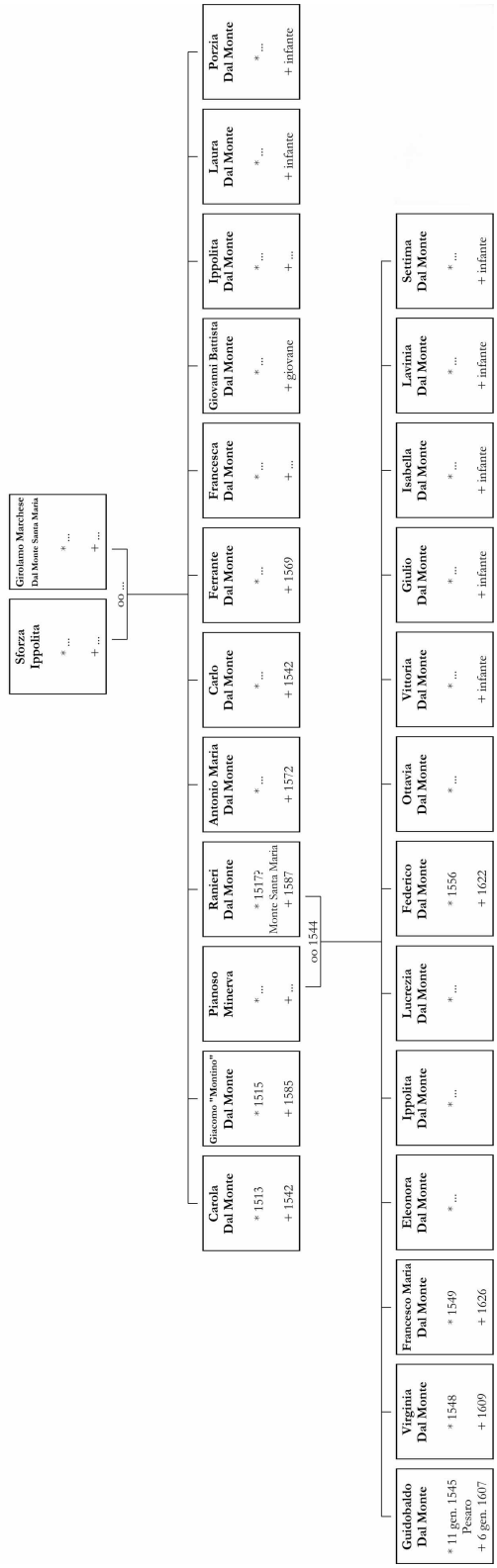

Figure I.2: Ranieri dal Monte's genealogical tree.

the Duchy's infantry.[1] The report of the Venetian ambassador Lazaro Mocenigo at Urbino in 1571 characterises him as one of the four most influential persons around the Duke.[2]

Figure I.3: A panorama of Mombaroccio.

Figure I.4: The city gate of Mombaroccio.

In 1544 he married, apparently with the Duke's mediation, Minerva Pianosi, the daughter of a prosperous merchantman (cf. Ranieri's family tree in I.2) -[3] another important factor that ensured the wealth of the dal Monte, besides the concession of mills by the Duke.

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cf. fol. 254r): "partendo <il Duca> da Pesaro per Urbino, raccomandò questa città al Sig. Raniero de' Marchesi del Monte di Santa Maria (...)." Ranieri seems to have assumed the task as *Governatore* of Pesaro later than 1561: in the prefaces of the first edition of Atanagi's work, this information is omitted, while it is reported in the second and third editions of 1582/1601, cf. Z. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, 2 vols., Firenze, Olschki, 1994; vol. II, section II.2.

[1]Bernardo Tasso, present in Urbino with his son Torquato from 1557 until 1559, gives us in his *Amadigi* (Venezia 1560), a hint to the central position of Ranieri at the court, cf. the verses on page 23. Cf. also BOP, ms 758: "La cagione fu che egli <Ranieri> mentre veniva tanto amato et onorato dal S.r Duca si portò sempre con tanta fedeltà e tanto amore che da tutti universalmente e singolarmente si rese amabilissimo, onde il medesimo S.r Duca avendo a core la persona sua si compiaque onorarlo ancora di titolo di Conte e gli donò il detto castello <di Monte Baroccio>. Il tempo fu nell'anno 1543."

[2]Cf. A. Segarizzi (edit.), *Relazioni degli Ambasciatori veneti al Senato*, 4 vols., vol. II, Bari, Laterza, 1913; p. 191: "Quelli, li quali sono continuamente appresso la sua persona e pochissima parte del giorno si allontanano da lei: sono prima il Signor Pietro Bonarelli, il quale è sopramodo caro al Signor Duca ed ha il titolo di Capitano generale della Cavalleria, ed è quello che può ogni cosa appresso Sua Eccellenza, con qualche risentimento del Principe; il Conte Fabio Landriano, che ha una nipote del Duca per moglie; il Signor Rainer del Monte, che è suo Capitan generale de' Fanti; ed il Conte di Montebello che ha per moglie una sorella del Conte Pietro predetto. (...)" See Appendix II, I.1 and especially I.2. This fact is confirmed also by the excerpt of B. Tasso's *Almadigi*, reported at the beginning of the present paragraph. Letters between the Duchess and Guidobaldo II (cf. Appendix I, I.2) are ulterior proves of Ranieri's outstanding role at court.

[3]The father of Minerva was Cavalier Sebastiano Pianosi. Besides being a wealthy merchantman, he had also some importance at court.

So this was the context in which Guidobaldo dal Monte, born in 1545 as the first of thirteen children of Ranieri and Minerva Pianosi, grew up: member of one of the most influential families of the Duchy, strictly connected with the court.
But not only the close relation to the court turns out to be decisive for a better understanding of Guidobaldo's biography and, ultimately, of his scientific activity, also other aspects of Ranieri's life and work are relevant in this regard: even the former's dedication to technical and scientific activities seems to have been conditioned by his father. In fact, Ranieri had written books on military architecture and astrology which indicates some interest in theoretical studies.[1] Also his tasks in the capacity of military architect and captain – which obviously required the cognition of mechanics and machines – plausibly led to Guidobaldo's first contact points with mechanics.

Thanks to his notable diplomatic ability Ranieri succeeded in conserving the eminent role of his family in the Duchy: he integrated his sons in the court of the young Prince Francesco Maria and after Guidobaldo II's death in 1574, Ranieri remained a loyal and competent subject in the service of the new Duke: several extant letters show him busy with tasks commissioned by Francesco Maria II.[2] It was only after his death in 1587 that problems arose between the dal Monte house and the Duke of Urbino.[3]

[1] Cf. D. Bonamini, *Abecedario degli architetti e pittori pesaresi*, ed. G. Patrignani, in "Pesaro città e contà", VI (1996), p. 69: "È unito a questo codice intitolato *De architettura militari libri duo* altra opera dell'istesso Raniero *De astrologia libri tres* e tra l'uno e l'altro codice sono pagine 368 (...)." See Appendix II, I.2.

[2] Cf. Appendix II, I.2.

[3] Cf. Appendix I, I.5.

I.2 Guidobaldo's life

Antica fama al Sicilian dà laude
Che mosse i monti e numerò l'arena
Hor Guidobaldo a Voi novella applaude
Novella sì, ma più lucente e piena
Voi mireranno i secoli futuri
Splender lassà nel ciel fiamella eterna,
Quando già fian mille famosi oscuri,
Se verace valor gl'omini eterna.

Baldi about Guidobaldo in *Concetti morali*, p. 51.

Guidobaldo dal Monte[1] was born on the 11th[2] of January 1545 in Pesaro. His godfather was, significantly for the importance of his family, the Duke of Urbino himself – to whose honor Guidobaldo took his given name.[3]
Guidobaldo passed his first years at the Duchess' court,[4] in the midst of Countesses (among them Minerva Pianosi, his mother) and other children, given Ranieri's

[1]It seems advisable to dwell a bit on the various, sometimes incorrect variants with which Guidobaldo is (and was) referred to literature: the incoherency about the orthography of his name in the present literature is paralleled by the manifold variants from the sixteenth century: his given name is reported as "Guid'Ubaldo, Guidubaldo, Guido Baldo"; his surname has been erroneously referred to as "Ubaldus, Ubaldi", on the basis of the Latin form of his name "Guidus Ubaldus". While, nowadays, the form "Guidobaldo", with which he signed, seems stabilised (surely wrong, in this context, is Drake&Drabkin's nomination "Guido"), there are still divergences about the particle "del, dal". In this regard, once again, there have been incoherent forms already in the sixteenth century. The constant, however, in these incongruences is the way in which the members of the family themselves signed: in fact, Ranieri as well as Guidobaldo and Francesco Maria (as well as the others), constantly use the "dal"-form, which seems to hint at a family convention. The appropriate from of his surname would therefore be "Guidobaldo *dal* Monte". This confusion might partly be derived from the denomination of the noble family Guidobaldo's family stemmed from: the Marchesi *del* Monte Santa Maria, sometimes also called Bourbon del Monte.

[2]Some sources quote January 2nd as his birthday. This is a confusion basing on the fact that BOP, ms 758, *the* fundamental description of Guidobaldo's life, reports the numeral "11" as two simple vertical bars. Some readers must have interpreted this notation as Roman numerals and reported consequently "2". Yet, the additional information adduced by BOP, ms 758, fixing his birthday to Sunday – "l'anno fu 1545, il mese fu di genaro alli 11 il dì fu di domenica l'ora fu alle 12 e mezza in circa" – permits to doubtlessly identify it with January 11th, cf. A. Cappelli, *Cronologia Cronografia e Calendario perpetuo*, Milano, Hoepli, 1988.

[3]Cf. BOP, ms 758, page 2 (not numbered), see Appendix I, II.2.

[4]For the existence of several distinct courts around Duke, Duchess, Prince and Princess, note what the Venetian ambassador Lazzaro Mocenigo wrote in 1571: "Spende Sua Eccellenza <Guidobaldo II> molto largamente, ed oltre il trattenere un'onoratissima corte, anzi più corti, cioè la sua, quella del Principe, della Duchessa e della Principessa, qual tutte son piene di molti gentiluomini (...)". Cf. Appendix II, I.1.

and the Duke's frequent absences.[1] In this context, he made his first journeys: after Prince Francesco Maria della Rovere's[2] birth on February 20th 1549, Vittoria Farnese's court betook to Venice in spring and stayed there until autumn 1549. The Duchess and her entourage passed some time close by the *Condottiere*-Duke Guidobaldo II, and with him Ranieri dal Monte, who carried out missions at the service of the *Serenissima*.[3]
Three years after, Guidobaldo was called to enter into the young Prince's service. Notably, they ate at the same table – in those times a remarkable honour.[4]
The former's youth was, as far as it can be reconstructed,[5] characterised by a typical nobleman's education: along with Francesco Maria della Rovere, he was instructed in grammar and music,[6] as well as in fencing and horseriding.[7] Also other progenies of the most influential noble families of the Duchy were gathered around the young Prince, like Guidobaldo's brother Francesco Maria, Federico Bonaventura, the Prince's cousins Ippolito and Giuliano della Rovere, his sisters Isabella and Lavinia della Rovere, probably the brothers Giulio and Pier Matteo Giordani and others,[8] as well as intermittent guests of the court like Torquato Tasso.

[1]Cf. in this regard the letters between Duchess Vittoria Farnese and Guidobaldo II in Appendix I, I.1.1. Note also that the letter written on August 3rd 1551 speaks about "S.r Ranieri's child" afflicted by a serious illness, the Duchess hoping that he will not die from the disease. It is not clear if the question is about Guidobaldo or his brother Francesco Maria.

[2]Francesco Maria was to be the future Duke of Urbino reigning from 1574 until 1631, as Francesco Maria II della Rovere. He was the last Duke of Urbino since the Duchy passed under the control of the Pontifical State after his death.

[3]So it was at Venice, where Guidobaldo's brother Francesco Maria dal Monte, the future Cardinal and Caravaggio's patron, was born, on July 5th.

[4]Cf. BOP, ms 758, see Appendix I, II.2.

[5]Cf. BOP, ms 758 in Appendix I, II.2.

[6]As teachers of Guidobaldo are recorded Lodovico Corrado in grammar, and Father Costanzo Porta as well as Paolo Animuccia, the brother of the famous Giovanni Animuccia, in musics.

[7]Also Filippo Pigafetta's letter to Guidobaldo (cf. BAM, R121sup, fols. 14r-15r) of November 5th 1580 hints to Guidobaldo's military skills, doubtlessly acquired from his childhood on: "et essendomi celebrata da tutti la sua nobilissima natura, et il valore nell'armi e nella cavalleria, e la dottrina in ogni scienza tal che in quella venga a sovrastare a ciascun'altro Signore et a non esser secundo a niun letterato (...)."

[8]The membership of the Giordani brothers of the court is of interest, as Pier Matteo was Guidobaldo's closest scientific interlocutor. A hint at their actual connection to the court in youth is contained at fol. 115r of BOP, ms 426 (letter from Francesco Maria dal Monte to Giulio Giordani, 1608): "V.S. può essere sicurissima che un'amicitia di 55 anni non si può mai cancellare. Si ricorda quando giocavamo al pallone – *heu quanto melius* – con le Artemisie, Cleopatre? Et pur passa ogni cosa. Io son Suo al solito et La saluto. Come fratello amorevolissimo Il Card.le dal Monte": "Cleopatra" appears to be an allusion to Isabella della Rovere, as another letter of Francesco Maria reveals (cf. BOP, ms 426, fols. 83r-84v). "Artemis" could therefore be the nickname of another female member of the Prince's court, like Lavinia della Rovere.

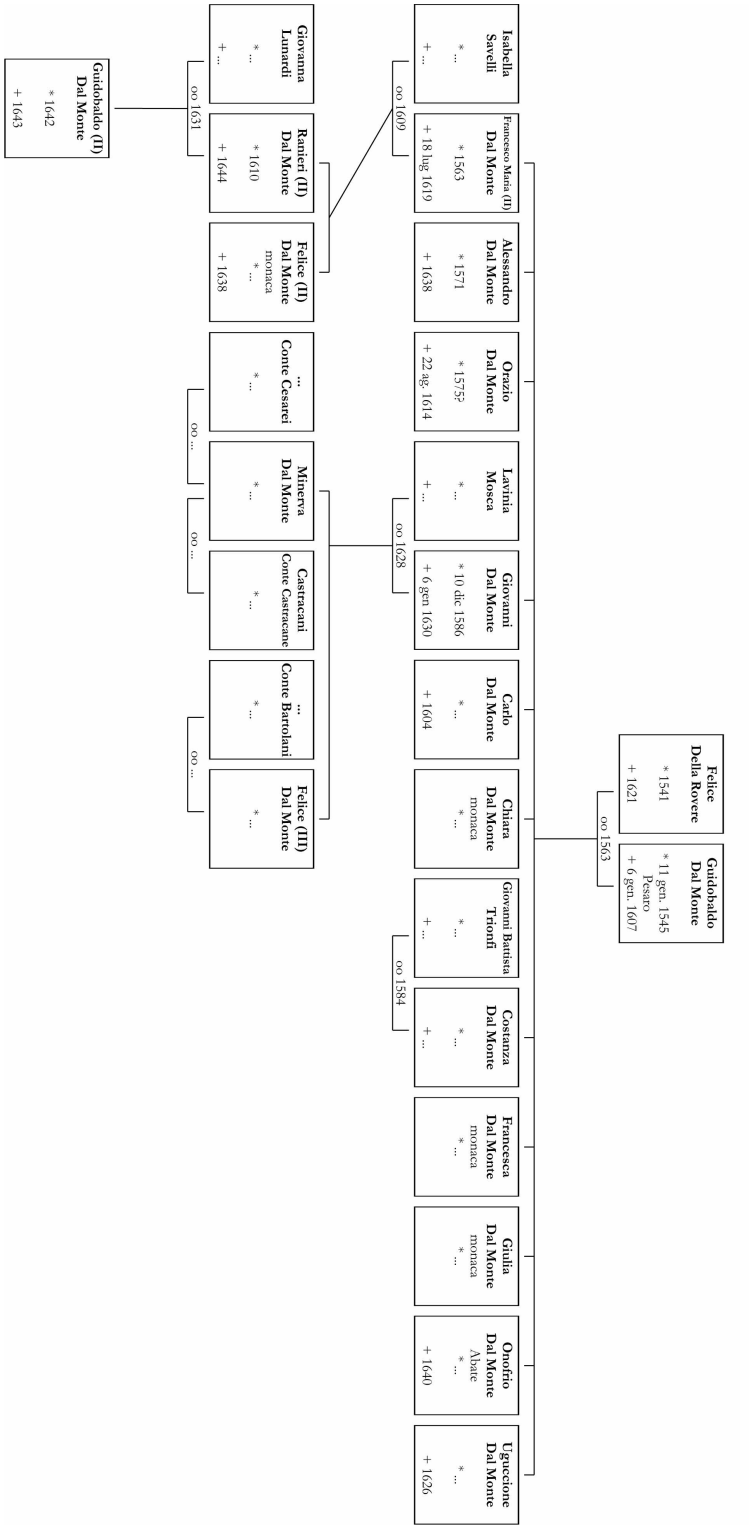

Figure I.5: Guidobaldo's genealogical tree. We have reported only his children who have survived childhood.

Around the year 1560,[1] Guidobaldo was conceded by the Duke to take his illegitimate daughter Felice della Rovere for his wife. A greater privilege was hardly imaginable and permits to comprehend the brilliant relations that must have been maintained between Ranieri and Guidobaldo on the one hand, and Guidobaldo II as well as Prince Francesco Maria on the other in that period – as the following account will show, however, the things were not to remain in this way. Anyway, Guidobaldo henceforward was formally related with the reigning family of the Duchy. Then in 1563, his first son Francesco Maria (II)[2] was born.[3] Presumably prior to the end of 1563, Guidobaldo – and, apparently, his brother Francesco Maria dal Monte – had betaken to Padua, in order to attend its famous *Studio*, the university centre of the Venetian Republic.[4]
Guidobaldo's initial aim was to attend lectures on philosophy. Then, however, he was more attracted by his increasing passion for mathematics.[5] Apparently, he frequented *inter alia* Pietro Catena's lectures on Aristotle's[6] *Quaestiones Me-*

[1]Various sources disagree about the wedding year: BOP, ms 758 quotes the year 1559 ("Quando <Guidobaldo> fece il sposalitio avea 14 anni"). Other sources report different years. A *terminus ante quem* is the year 1563: Felice signs in a letter, written on 12 November 1563 (conserved at BCF, Collezione Piancastelli, Carte Romagna 629.42) as "Felice Rovere dei Mar.si del Monte". A further hint might be contained in the preface of D. Atanagi's *De le lettere facete*, cit., which reads in regard: "et al Signor Guidobaldo vostro primogenito figliuolo, giovanetto d'alta speranza, dia per consorte la Illustrissima Signora Felice Rovere sua figliuola." The use of the present tense ("dia") instead of the past tense ("dette"), in contrast to the precedent phrase, suggests that Felice della Rovere has already been affianced in 1561, the edition year of the *De le lettere facete*, but that the marriage has not yet been solemnised. In effect, the confusion about the precise year seems to derive from a confusion of the engagement and the actual wedding. Anyway, neither Waźbiński's quotation of 1571 as wedding year, nor Montani's (cf. BOP, ms 965, "Pesaresi Illustri", fol. 130r) of 1567 can be right.

[2]We use the numbering "(II)" in order to distinguish Francesco Maria, Guidobaldo's son, from Francesco Maria, Guidobaldo's brother and future Cardinal, and, on the other side, from Francesco Maria II (della Rovere), the future Duke of Urbino.

[3]About twenty five years later, 17 children had been born to Guidobaldo and his wife Felice della Rovere dal Monte, eleven of whom survived childhood, cf. figure I.5. Very little is known about these children, with only few exceptions. Frequently, there is not even any cognition about their dates of birth and death, not to speak of details on their lifes. Studies on this topic would be a *desideratum*, since they would contribute to a better comprehension of Guidobaldo's biography.

[4]It is plausible to antedate Guidobaldo's Paduan stay compared to the usual quoting of 1564 – based substantially on BOP, ms 758 – on the ground of a recently found letter (ASF, Ducato di Urbino, I, 217, fol. 335r) from the Paduan Colonel Agostino Clusone to the Duke of Urbino, cf. Appendix I, I.1.2.

[5]BOP, ms 758 writes: "<Guidobaldo> andò a Padoa per lo studio della filosofia, ma più vivamente attendeva alle dette matematiche", cf. Appendix I, II.2.

[6]The debate on the authorship of the text is still open, some scholars attribute it to Aristotle personally, other consider it as a work of a disciple. For the sake of brevity, we will call it here an "Aristotelian" writing.

chanicae.[1] And probably it has already been in this period that he and his brother got to know Jacobo Mazzoni.[2]
Guidobaldo's stay a Padua is reported to have lasted only one year,[3] even if the possibility of a longer stay should not be excluded.[4] Anyway, Guidobaldo Paduan stay continues to remain nebulous; but in-depth studies on it would be a *desideratum* given that it surely constituted a highly formative period.[5]
There is some reason to suppose that Guidobaldo, in the context of his Paduan period, went to Venice in May-June 1564: Duke Guidobaldo II undertook a trip to Venice with his court, accompanied by his son Francesco Maria, presumably with his own court. Given that Guidobaldo was among the Prince's intimates, it can be assumed that he did move from Padua to the nearby Venice and attend the respective ceremonies.[6]
Again in 1564,[7] the city residence of dal Monte family was built at Pesaro: it

[1]The information that Guidobaldo attended Catena's lectures comes from Ireneo Affò, *La Vita di Monsignore Bernardino Baldi*, Parma, Carmignani, 1783, p. 9, who cites a passage of Guidobaldo's *Vita* (now apparently lost), written by Baldi.

[2]Mazzoni was to become an important philosophical interlocutor both to Guidobaldo as to Galileo. He reached a very high reputation as philosopher of the Italian *Cinquecento*. He as well took up his studies at Padua in November 1563. For a more detailed description of his life and friendship to the dal Monte family, cf. Appendix II, II.1, "Jacopo Mazzoni".

[3]Cf. BOP, ms 758; see Appendix I, II.2.

[4]Guidobaldo had been maintaining excellent relations with the Paduan community of scholars around Gian Vincenzo Pinelli and Giacomo Contarini, considering the conspicuous number of letters between Guidobaldo and that community; further, as their analysis reveals, the Marchigian mathematician knew Pinelli's copy of Pappus's *Collectiones Mathematicae* very well: this hints at a profound scientific exchange. Was it possible to get in such an acquaintance in only one year? In effect, Waźbiński supposes a longer stay of Guidobaldo at Padua. Yet, a five-years-stay, as hypothesised by the Polish scholar, seems exaggerated. A possible end of the Paduan period could have been marked by his participation in the military campaign in Hungary in 1566, as we will expose in the following.

[5]Among the most interesting questions are: which lectures did he frequent besides the one held by Catena? Did he frequent one of the Paduan academies, which dealt also with mechanics? Is the information, reported by BOP, ms 758 (and repeated by all modern biographies), about the one-year-duration veridical? Was he recommended by the Duke to some professor of prestige (note that recommendations to famous professors, certificated by Duke Guidobaldo II to subjects of his Duchy, were not unusual, cf. Waźbiński, p. 26. Note in this context also to the Duke's recommendation for Ranieri's sons to the Paduan Colonel Clusone).

[6]The official purpose of the trip were the Ascension ceremonies. The main goal of the mission, however, was the negotiation on a contract about the Duke's military service for the Venetian Republic, as well as the conclusion of a similar agreement for his son. In the number of the Duke's entourage there were the major exponents of the Urbino court, like Cardinal Giulio della Rovere, Ranieri dal Monte, Count Pietro Bonarelli and many others. There is good reason to believe that the presence of the Duke's court was paralleled by the participation also of the Prince's court; cf. Z. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, 2 vols., Firenze, Olschki, 1994, pp. 21-25.

[7]Again, in 1564, also the city walls of Pesaro were finished, as L. Firpo tells (p. 39), after a 30 years period of works. Surely, Ranieri and his son Guidobaldo observed the work in progress with attention. It is not to exclude, that at least the former had also some responsibilities

is a huge, majestic and still conserved edifice in the close neighbourhood of the *Palazzo Ducale*.[1] It must have been an important centre of the political life in the Duchy, considering the fact that the future Duke Francesco Maria II seems to have been rather familiar with the building.[2]

In 1566,[3] Guidobaldo accompanied the renowned Aurelio Fregoso[4] on a military campaign in Hungary with 3000 men, in service of the Grand Duke of Tuscany.[5] Even if we continue to be ignorant of Guidobaldo's precise role in this campaign,[6] beyond any doubt it constituted an important event in the young nobleman's life: it was probably meant to be the first move to follow in the footsteps of important members of his family: Ranieri, Montino, Giam Battista dal Monte, they all were famous and influential captains and generals. Presumably Guidobaldo, as

concerning these works, given that he was *Governatore* of Pesaro.

[1]Cf. G. Allegretti, *Monte Baroccio 1513-1799*, Comune di Mombaroccio, Le penne studio editing, 1992, p. 56. The impressive building, nowadays called *Palazzo Del Monte-Baldassini*, is located in Via San Francesco, at a 100 meters distance to *Piazza del Popolo* and the *Palazzo Ducale*.

[2]In fact, the architect Girolamo Arduini, in his proposals for the ornaments of the ducal Villa Vedetta, refers to the dal Monte city residence, proposing a certain kind of stone for the Villa Vedetta. Cf. BOP, ms 434 fols. 19r ff.: "Se vorrà conci alle finestre et altri ornamenti allo scoperto, la meglio è la pietra di Curzola, o vero di quella del Furlo, che sono fatto le cantonate al palazzo del S.r Raniero <dal Monte>, et li pilastri della Loggia grande della corte in Piazza di Pesaro."

[3]BOP, ms 758 quotes no precise year for this event and describes Guidobaldo as "about 22 years"-old. It is plausible to assume the military campaign to have been executed in 1566: as he is told to have been in Aurelio Fregoso's company, and as the later was on a military campain in Hungary in 1566 (cf. the documents below and in Appendix I), there is little doubt regarding this date. 1566 was the year in which Suleiman attacked Szigetvár.

[4]Aurelio Fregoso further was the father of Guidobaldo's brother-in-law Ottavio who had his sister Virginia dal Monte in 1564.

[5]Beyond this fact, details regarding Guidobaldo about this enterprise are unknown. Some light, at least on some reference values of the campaign, is shed by a letter recently found in the Florentine State Archive, written by Aurelio Fregoso from Györ (Hungary) and dated September 21th 1566. Therein, the *condottiere* reports on the Ottoman movements and sends military drawings of strategic places in his proximity (cf. ASF, Mediceo del Principato, 522, fols. 809-810; see Appendix I, I.1.3). We can fix the end of this campaign prior to February 1567: a *terminus ante quem* is constituted by a letter from the Florentine court to Fregoso, who was on the Island of Elba at that time, at Portoferraio (cf. ASF, Mediceo del Principato, 5923, fols. 32r ff., see Appendix I, I.1.3.) Although the quoted data is February 18th 1566, it corresponds to February 18th 1567 according to the modern calendar – in fact, the Florentine calendar observed, from the 10th century until 1749, the style *ab Incarnatione*: a new year began with March 25th, postponed regarding the modern calendar. From March 25th to December 31th it corresponded with it.

[6]For example, it is not clear if Guidobaldo was involved in real battles: the fortress Szigetvár fell, after a month's besiege, on September 7th of 1566, that is before the date of Fregoso's letter to the Grand Duke of Tuscany. Peace negotiations were held from the summer of 1567 on and, after half a year, the Treaty of Edirne was signed on 21 February 1568.

well, (was?) intended to follow their example. In any case, his contact with the military *milieu* was anything but secondary for his interest in mechanics.[1]

Not very much later, Commandino began to teach mathematics at Urbino, on initiative of Prince Francesco Maria, with particular focus on Euclid's *Elements*.[2] Guidobaldo attended to those lectures as well.[3] There is strong evidence that these studies started in the period comprised by the end of 1568 and the beginning of 1569.[4] Consequently, the beginning of Guidobaldo's studies with Federico Commandino can plausibly be dated to this period, too.[5] They should have influenced Guidobaldo's whole scientific activity: more generally, they created and reinforced in Guidobaldo a strong interest and approach to ancient mathematics, common with other scholars of Commandino like Baldi. For numerous shared aspects of their works, the group is assembled with the classification "School of Urbino".[6]

[1]The campaigns of those times required the transport and lifting of huge weights, e.g. of cannons, and entailed the application of mechanical machines, cf. M. Henninger-Voss, *Working Machines and Noble Mechanics. Guidobaldo del Monte and the Translation of Knowledge*, in "Isis", XCI 2 (2000). Further, the trajectory of cannonballs was another problem that arouse the interest of sixteenth-century scholars of mechanics. Plausibly, Guidobaldo had occasion to apply what he had learned from his father, an expert of military architecture, cf. Appendix II, I.2.

[2]In the *Vita di Federico Commandino*, Bernardino Baldi writes: "attendeva egli <Commandino> adunque a condurre a fine molte opere già da lui cominciate, quando Francesco Maria, figliuolo di Guid'Ubaldo <II> nostro Duca, giovane d'animo eroico, sapendo quanto quelle scienze stiano bene a chi è per dar opera all'arti militari, non comportò che Federico se ne stesse rinchiuso fra le mura della casa paterna, ma propostogli onoratissimi partiti, volle, come aveva già fatto il Padre, chiamarlo ai suoi servizi; nei quali entrato leggendo a quel Principe gli *Elementi* d'Euclide apportava lui molta sodisfazione nell'interpretarli." Cf. B. Baldi, *Vita di Federico Commandino*, in "Giornale de' Letterati d'Italia", 1714, 19, Articolo VI, pp. 140-185. Cf. also *Le vite de' matematici. Edizione annotata e commentata della parte medievale e rinascimentale*, ed. by E. Nenci, Milano, Angeli, 1998.

[3]Cf. BOP, ms 758: "<Dopo il soggiorno a Padova Guidobaldo> se ne tornò alla corte al med.o servitio del S.r Prencipe come prima; né perciò desisteva punto dalli suoi incominciati studii, per il ché per suo maestro singulare ebbe il S.r Federico Comandino (...)."

[4]An article which concludes this fact on the basis of three independent sources is forthcoming: the young Prince had returned home in the summer of 1568 after a biennial stay at the royal court at Madrid. After some months – as Francesco Maria II's autobiography claims – the Prince "turned to his studies interrupted during his absence from Italy. He read mathematics with Federigo Comandino (...)." The veracity of this report is supported by two letters written by a Duke's agent in Venice which testify the efforts made to provide the Prince with books on mathematics.

[5]Even if this scenario is probable, it cannot be excluded, though, that Guidobaldo had begun his studies under Federico Commandino after his return from Hungary and before the Prince's from Madrid. In this case, the start would be antedated by about a year.

[6]These common aspects of their works comprise the ideal of Greek mathematics; a rather philological style; the high text adherence etc. Nevertheless, as every socio-cultural classification, the term "School of Urbino" should not induce to consider Commandino, Guidobaldo, Baldi and Oddi as a monolithic group of scholars. Their lifes and works present also remarkable

At that time, Commandino was working on the edition of Pappus's *Collectiones Mathematicae*, making also his disciples work on his translations.[1] This contact with the Pappian work was a relevant element of Guidobaldo's formation: as he himself stated,[2] besides Archimedes's writings the eighth book of the *Collectiones Mathematicae* was the model for the *Mechanicorum Liber*, his first and principal work in mechanics.
There are some reasons to suppose that Guidobaldo, parallel to the mathematical lectures and afterwards, studied also philosophy with the Prince, under "Cesare Benedetti, Giacomo Mazzoni, and Cristofero Guarimone".[3] Given his closeness to the Prince and the court in those times on the one hand, and his erudition and interest in philosophy on the other,[4] this hypothesis seems more than possible.

Despite of Guidobaldo's first advanced mathematical studies in these years, the socio-political events of the Duchy continued to involve him, giving the Prince allegiance.
At the beginning of 1570, Duke Ottavio Farnese was guest of the della-Rovere-court. In this occasion at the latest, Guidobaldo must have come to know the sovereign of Parma, whom he considered "to be well versed in mathematics and

divergences. In effect, D. Bertoloni Meli, *Guidobaldo dal Monte and the Archimedean Revival*, in "Nuncius", VII 1, 1992, pp. 3-34, evidences the limits of this classification. Another important conceptual divergence between Guidobaldo's and Commandino's works is highlighted in M. Frank, *Commandino e Guidobaldo: La Proposizione 6 della Quadratura della Parabola e la questione dell'equilibrio*, in "Proceedings International Workshop on Commandino, Urbino 2009", forthcoming.

[1] At the Biblioteca Universitaria Urbino, Fondo del Commune, Busta 121, fasc. 5, some of Commandino's drafts on the *Collectiones Mathematicae* are preserved. P.L. Rose further cites, in *Plusieurs manuscripts autographes de F. Commandino à la Bibliothèque Nationale de Paris*, in "Revue d'Histoire des Sciences", 1971, XXIV 4, pp. 299-307, a manuscript (BNF Latin 1144) that corresponds to the third book of the *Collectiones Mathematicae* and contains many notes and corrections written by Guidobaldo.

[2] Cf. the preface of the *Mechanicorum Liber*, p. vi (not numbered): "Mechanici praeterea fuerunt Heron, Ctesibius et Pappus, qui licet ad mechanicae apicem, perinde atque Archimedes, evecti fortasse minime sint; mechanicam tamen facultatem egregie percaluerunt talesque fuerunt. Et praesertim Pappus, ut eum me ducem sequentem nemo (ut opinor) culpaverit. Quod et propterea libentius feci, quod ne latum quidem unguem ab Archimedeis principiis Pappus recedat. Ego enim in hac praesertim facultate Archimedis vestigiis haerere semper volui."

[3] Cf. BOP, ms 386 fols. 218r-229r, Francesco Maria's autobiography: "ritornò <Francesco Maria della Rovere dopo il suo soggiorno in Spagna> alli suoi studi tralasciati mentre era stato fuori d'Italia, li quali furono prima di matematica lettagli da Federico Comandino, poi di filosofia da Cesare Benedetti, Giaccomo Mazzone e Cristofero Guarimone (...)."

[4] B. Baldi, for example, writes in his *Cronica* "Ha egli <Guidobaldo> buona cognizione (...) delle cose filosofiche (...)"; Sebastiano Macci, a local contemporary writer names him in his *Vita* "philosophus et mathematicus". Further, he owned books on philosophy, as his last will of 1607 evidences: "All'Ill.mo Sig.r Alessandro suo figlio lasciò i libri di Legge, Theologia et Filosofia" (cf. Appendix I, I.6.5). For further information on Guidobaldo's occupation with philosophy, cf. Part A, V.1.1.

most expert of the art of warfare" and to whom he dedicated his work *Planisperiorum universalium Theorica* nine years later (1579).[1]
Then, in January 1571 Francesco Maria della Rovere's marriage with Lucrezia d'Este, sister of Duke Alfonso of Ferrara, was celebrated. The bridegroom went to Rimini in company with a large procession of noblemen of both duchies, in order to meet his bride half way and to take her to Pesaro. The young Guidobaldo had the honour to form the Prince's personal escort during this trip, together with few other members of high standing in the Prince's court.[2]
Later in that year, one of those times' greatest military conflicts took place: the naval Battle of Lepanto. Intending to support the Christian League, also Prince Francesco Maria, in company with a young noblemen's group and a conspicuous contingent of soldiers of the Duchy, betook himself in June from Urbino over Genoa to Naples and Messina.[3] Guidobaldo, who was among them,[4] had incurred, however, a serious attack of sciatica during the journey, and, constrained to stay in Messina,[5] missed the battle.[6] If the information about the birth date of Guidobaldo's son Alessandro is right,[7] he had turned home from the Sicilian seaport approximately prior to October.
The consequences of Guidobaldo's illness, though, were much more far-reaching than the missed participation in the Battle of Lepanto: he remained rather health-

[1]Cf. the preface of *Planisperiorum universalium Theorica*, pp. iv/v (not numbered): "Non enim me latet, te mathematicis scientiis ne dum plurimum oblectari, verum etiam in iis diu versatum fuisse; ne quicquam ad rei militaris disciplinam, quae apud te plurimum viget (in exercitibus enum regendis ac gubernandis es peritissimus) tibi deesset."

[2]Other components of the escort were the Prince of Massa and Ippolito della Rovere. An account of the marriage ceremonies is given in Dennistoun, *The Dukes of Urbino*, cit. For Guidobaldo's role, cf. BOP, ms 377, see Appendix I, I.2.2.

[3]In Genoa, the Urbinate company met Don Juan de Austria, the commander-in-chief of the campaign. After a stop in Naples, they reached Messina, where a general war council was held, cf. Dennistoun, *The Dukes of Urbino*, cit., pp. 131ff.

[4]Another participant in the Prince's fellowship was Giambattista Bonarelli, Pietro Bonarelli's son. The latter was another very important person around Duke Guidobaldo II. Giambattista died in the battle, cf. L. Firpo, *Lo Stato ideale della Controriforma. Ludovico Agostini*, Bari, Laterza, 1957, p. 103.

[5]This fact immediately entails an important question: did Guidobaldo make acquaintance with Francesco Maurolico, who lived and worked in Messina? An answer would not be insignificant considering the monk's notable (and until the seventeenth century unpublished) works on mechanics. Guidobaldo might have heard of Maurolico from his teacher Commandino: in his Archimedes edition of 1558, he wrote that Maurolico was preparing a new *interpretatio* of Archimedes. In a letter to Maurolico (cf. P.L. Rose, *The Italian Renaissance of Mathematics*, cit., p. 196) he further shows to have known about the former's work on *De Momentis aequalibus*. The actual known documentation, however, does not permit to resolve this problem.

[6]Cf. BOP, ms 758 in Appendix I, II.2.

[7]According to BOP, ms 1063 ("Cenni biografici di uomini illustri Pesaresi del Cav. Bonamini"), tomo I, fol. 295v, Alessandro dal Monte, bishop of Gubbio, was born on June 28th 1572. This implies Guidobaldo's presence at Pesaro about nine months before, i.e. approximately in September.

impaired for all his life,[1] and had to give up his military career. This means a crucial moment for the comprehension of his scientific activity: Guidobaldo, at this turning point, abandoned the project of a military career in the service of the della Rovere and decided to dedicate (consistent parts of) his life to mathematical studies.[2]

In fact, the first extant testimonies of Guidobaldo's occupation with mathematics and its applications date from little later: Muzio Oddi's *De gli Horologi Solari* report that "in the year 1572, the most Illustrious Sir Guidobaldo de' Marchesi del Monte had one <of the clocks of refracted rays> constructed by the excellent artificer Simone Baroccio, in a semi sphere of brass",[3] which served then as model for a copy for the Prince. At that time, Guidobaldo must have frequented with regularity the workshop of precision instruments led by Barocci in Urbino:[4] the existence of this office was another factor that conditioned Guidobaldo's work, since he attended also to the invention and construction of several mechanical instruments, besides his occupation with theoretical studies.[5] Even a central aspect of his mechanical theory seems to be related and, in a certain measure favoured in its evolution by his access to and use of high-precision instruments, namely his theory of indifferent equilibrium.[6]

In this context, also Guidobaldo's invention of the proportional compass, reported by Oddi in the preface of *Fabrica et Uso del Compasso polimetro* can plausibly be dated, at about this period.[7]

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[1] Apart from the passage of BOP, ms 758 – "La sciatica (...) gli durò infine della vita, con tutto che per consigli dei medici di Padoa dove andò aposta a curarsi per liberarsene, bevesse sempre l'aqua che per esser stata gravissima lo tenne lungo tempo in letto" – there are several letters in his correspondence hinting to his poor health. Moreover, the Duke of Urbino himself referred to Guidobaldo's poor health in the letter with which he sent Guidobaldo's treatise *De Ecclesiastici Calendarii Restitutione Opusculum* to Rome in order to present it to Pope Gregory VIII. On the topic of Guidobaldo's poor health, cf. Appendix I, I.3.1).

[2] Cf. BOP, ms 758: "La sciatica gli venne quando andò all'Armata (...) e gli durò infine alla fine della vita (...), talmente impedito che [egli convene] lasciar la servitù del S.r Duca e la Guerra, per il che si diede a tutto potere alli studii di Matematica." The statement about his complete retirement from the Prince's services, however, seems to refer to a later period, as we will see in the following. However, it is a hint that Guidobaldo from that moment partly abandoned the courtly life – with positive effects for the time he could dedicate to his studies.

[3] Cf. M. Oddi, *De gli Horologi Solari*, pp. 99/100.

[4] This workshop had gained a national and even international reputation: several of their makes were offered as presents to Popes, Cardinals and Dukes. Moreover, Galileo had his military compass built there. A forthcoming article to be written with prof. E. Gamba is planned to deal with this topic.

[5] Cf. BNCF, mss Gal 88, fol. 136r (letter from Orazio dal Monte to Galileo; June 16th 1610): "io darei fuori volentieri (...) <un'opera su> la fabbrica di alcuni instromenti ritrovati da lui". The letter is published in G. Galilei, *Opere*, Vol. X and transcribed also in Appendix I, I.7.3.

[6] For further information about the topic of the indifferent equilibrium regarding the isostatic balances, cf. Part B, chapter I.

[7] For further information on this passage of Oddi's *Fabrica et Uso del Compasso polimetro*, cf. Appendix I, I.2.1. Among the many studies on the proportional compass undertaken by Rose,

Guidobaldo's first extant letter (of the year 1573),[1] constitutes another testimony of his mathematical of his studies, with a request of two books on gnomonics and hints at an astronomical instrument of brass in his possession. The same letter testifies Guidobaldo's uninterrupted services for the Duke: he declared "that Count Giovanni Battista and I are the masters of Pesaro, since there is neither the Duke, nor the Prince, nor princesses, nor duchesses, nor almost anybody else": he had apparently remained in Pesaro and was representing the Duke, while the latter seems to have been on a trip to Mantua with his court.[2]

In the winter of 1572/73 the Urbinate citizens revolted in occasion of new taxes imposed by the disliked Duke, manifesting their discontent also about the in the meantime secondary position of Urbino compared to Pesaro as new centre of the Duchy.[3] Once again, Ranieri dal Monte's important role in the State gets clear, by his central role in the efforts for a pacific solution of the conflict.[4]
Despite of the turbulent events of those years – or maybe exactly for this reason -, the court did not refrain from celebrating splendid festivities: a description of the events and spectacles in occasion of Carnival 1574 offers a rare, significant insight into the cultural *milieu* in which Guidobaldo grew.[5] Besides other events like theatrical performances, discussions took place about philosophy,[6] comprising topics like divergences between Plato and Aristotle about reminiscence, Epicure's philosophy, or about literature on different types of poetry. The frequent presences of Prince and Duke at these occasions reflect the interest towards such discussions and topics at the Urbinate court. The analysis of Guidobaldo's scientific work reveals some repercussion of this fact.[7]

Rosen, etc., cf. particularly E. Gamba, *Documenti di Muzio Oddi per la storia del compasso di riduzione e di proporzione*, in "Physis", XXXI (1994), pp. 799-809.

[1]Cf. BOP, ms 426, fol. 145r (December 16th 1573); see Appendix I, I.2.1. The letter is addressed to his friend Giulio Giordani, the future secretary and counsellor of Duke Francesco Maria II della Rovere.

[2]It is opportune to recall in this context that Guidobaldo's father Ranieri was the *Governatore* of Pesaro, cf. Appendix II, I.2. In the letter, Guidobaldo hints to "the Mantuans" who "will turn soon": this probably is an allusion to the fact, that the court was visiting in the meantime the Duke of Mantua.

[3]At Urbino, Guidobaldo II is still recorded as "Guidobaldaccio" – the Italian ending -*accio* expresses a derogatory opinion. For detailed accounts of the Urbino revolt cf. Dennistoun, *The Dukes of Urbino*, cit.; Firpo, *Lo Stato ideale della Controriforma*, cit.

[4]Cf. BOP, ms 377, fols. 241r-245v, see Appendix I, I.2.2. This source contains a contemporary narration of the revolt.

[5]BOP, ms 390, fols. 92r-97v, see Appendix I, I.2.2. A short passage of the letter has been transcribed in E. Gamba, V. Montebelli, *Le Scienze a Urbino nel tardo Rinascimento*, Urbino, Quattroventi, 1988, p. 31.

[6]The protagonists of these debates were Jacopo Mazzoni, guest of the dal Monte family (!) at Pesaro in this period, Torquato Tasso, Bernardino Pino and Cesare Benedetti.

[7]For further information about Guidobaldo's interest in philosophy and the respective traces of this circumstance in his work, cf. Part A, V.1 and V.2.4. For further information about

In September 1574, Guidobaldo II perished and was succeeded by the Prince, then called Francesco Maria II della Rovere, the sixth and last Duke of Urbino. The description of his coronation ceremonies highlights the importance of the dal Monte house in the Duchy once again:[1] Ranieri dal Monte guided the magistrates to the new Duke to make them swear fidelity, and officiated as attester of the oaths. During the procession, Guidobaldo, on the other side, was on the side of the fresh crowned Francesco Maria II hailed by his subjects.[2]
One of the new Duke's first actions was the divestiture and the bringing-to-justice of most of his father's courtiers and favourites, followed by a new distribution of the key positions of the state:[3] Guidobaldo replaced his father as the leader of the "Guard of the broken Lances", a kind of the Duke's life guard.[4] Ranieri, however, was one of the few "old-line" representatives who remained in Francesco Maria II's service, as the courtly payrolls and his correspondence with the ducal secretariat shows.[5]

The death of Commandino in the following year entailed profound changes for Guidobaldo's scientific activity:[6] first of all, it meant the loss of his appreciated master – two years after, he would have eulogised him as "dotated in that measure with mathematical talents that in him seemed to have lived again Architas, Eudoxus, Heron, Euclides, Theon, Aristarcus, Diophantus, Theodosius, Ptolemaeus, Apollonius, Serenus, Pappus and even Archimedes (...)".[7] Further, it entailed that thenceforward Guidobaldo represented the most authoritative scholar of mathematics in the Duchy: as exposed in the following, he frequently was commissioned as technical consultant of the Duke who moreover made him

Guidobaldo's participation in these festivities and his contact with the philosophers, cf. Appendix I, I.2.2.

[1]BOP, ms 390, fols. 98v-104r, see Appendix I, I.2.2.

[2]Cf. BOP, ms 390: "<Guidobaldo disse> che in quella occasione era necessario esser sempr'appresso la persona di S.Ecc.a come si vedde veramente, poiché il S.r Duca lo favoriva di burlar seco molte volte caminando a questa cerimonia con molte [deleezze]." See Appendix I, I.2.2.

[3]Cf. Appendix I, I.2.2.

[4]Cf. BOP, ms 1577, see Appendix I, I.2.2.

[5]For information about the payrolls, cf. Appendix I I.4.4. For Ranieri's letters to the Duke and Giulio Veterani cf., for example, BOP, ms 412 and ASF, Ducato di Urbino, I, 259; see Appendix I, I.2.

[6]Commandino died on September 3rd, 1575. His birth year, in contrast, is not doubtlessly clear, being either 1506 or 1509. This fact is emblematic for several aspects of Commandino's life and work, which continue to remain nebulous. In-depth studies in this regard would be a *desideratum*.

[7]Cf. the preface of the *Mechanicorum Liber*, pp. viii/ix (not numbered): "Erat enim summus iste vir omnibus adeo facultatibus mathematicis ornatus, ut in eo Architas, Eudoxus, Heron, Euclides, Theon, Aristarcus, Diophantus, Theodosius, Ptolemaeus, Apollonius, Serenus, Pappus, quin et ipsemet Archimedes (...) revixisse viderentur."

compose scientific treatises at his instance.[1] So, Guidobaldo became a kind of court mathematician from this moment on.

In 1577, Guidobaldo published his first work, the *Mechanicorum Liber*,[2] which is dedicated to explaining the operation mode of the five so-called "Simple Machines", i.e. lever, pulley, winch, wedge and screw. Machines were one of the fundamental subjects of sixteenth-century mechanics, their treatment, however, going back to ancient mechanics, namely to writings composed by Heron/Pappus[3] and Aristotle[4]. Guidobaldo reduced the machines' *modus operandi* to the lever, by having recourse to their geometrical properties and using the basic concepts of the Archimedean theory of mechanics. With this model for the machines, Guidobaldo notably contributes to the geometricalisation of mechanics' objects and concepts, away from the mythologisation of mechanical phenomena as "miraculous". Further, he made first steps in the direction of the statement of a general *compensation principle* for machines, then continued and brought to a conclusion by Galileo in *Le Mecaniche*. Another important aspect is Guidobaldo's prove of the existence of indifferent equilibrium for a special kind of balance.[5] For a more detailed description of the work see Part A, chapter IV.
The work had a deep impact on the scholars of mechanics. Only four years later, in fact, an Italian translation of Filippo Pigafetta, commissioned by the military Captain Giulio Savorgnan, appeared under the title *Le Mechaniche*.[6] This fact testifies a great interest in the topic also by people without cognition of Latin, like engineers or military captains whose jobs implicated the movement of huge weights and therefore the application of machines.
Some twenty years later, in 1615, the interest in the *Mechanicorum Liber* and

[1]For further information on this topic, cf. particularly Part A, IV.1 and Appendix I, I.3.

[2]Guidobaldo dal Monte, *Mechanicorum Liber*, Pesaro, Concordia, 1577. The complete, Latin title reads: *Guidi Ubaldi e Marchionibus Montis Mechanicorum Liber.*

[3]Heron's *Mechanica*, with its discussion of the Simple Machines was not known at Guidobaldo's lifetime and has been rediscovered only in the nineteenth century in an Arabic translation. However, Pappus had included a summary of the topic in the eighth book of the *Collectiones Mathematicae* and thus became the point of reference for Guidobaldo who knew the latter work by Commandino's works on it, as exposed above. For further information detailed information on Guidobaldo's sources and on sixteenth-century mechanics in general, cf. Part A, III.

[4]Also in Aristotle's *Quaestiones Mechanicae* the Simple Machines are dealt with – apart from the screw -, yet in a completely different way compared to the approach of Heron/Pappus.

[5]This topic turned out, in in-depth studies, to be one of the key arguments of Guidobaldo's mechanics. It will be exposed in Part B, chapter I.

[6]The complete title reads: *Le Mechaniche dell'Illustrissimo Signor Guido Ubaldo de' Marchesi del Monte. Tradotte in volgare dal Sig. Filippo Pigafetta. Nelle quali si contiene la vera dottrina di tutti gli istrumenti principali da mover pesi grandissimi con picciola forza. A beneficio di chi si diletta di questa nobilissima scienza, et massimamente di capitani di guerra, ingegnieri, architetti et d'ogni artefice, che intenda per via di machine far opre maravigliose e quasi sopranaturali. Et si dichiarano i vocaboli et luoghi più difficili.*

its translation must have still been unbroken, as both the Latin and the vulgar edition were re-edited, together with the posthumous edition of the *Cochlea*.[1] The book was soon known also outside Italy, as the German translation *Mechanischer Kunst-Kammer Erster Theil* testifies,[2] published by Daniel Mögling in 1629. Also A. García de Céspedes's treatise *Libro de instrumentos de geometría* (1606) published in Spain documents the impact of Guidobaldo's writing outside Italy.[3]
Further, the frequent citations of the *Mechanicorum Liber* in many coeval treatises on mechanics reflect the authority it had gained: Agostino Ramelli's *Le diverse et artificiose machine* (1588), Buonaiuto Lorini's *Le fortificazioni* (1597), Oreste Biringucci's Italian translation (1582) of Piccolomini's paraphrase on the *Quaestiones Mechanicae*, Luca Valerio's *Subtilium Indagationum Liber primus* (1582), Davide Imperiali's *Le Meccaniche mie* (after 1644)[4], and the *Mecaniche* of Galileo (ca. 1593) are only few examples, interestingly including works both with more technical on the one side, and more theoretical orientation on the other.

Two years after the publication of the *Mechanicorum Liber*, Guidobaldo released the *Planisphaeriorum Universalium Theorica* (1579), re-edited after another two years later at Cologne.[5] The treatise attended to the mathematical branch in which Guidobaldo seems to have been most interested besides mechanics, namely to perspective. His occupation with it led, twenty-one years later, to the edition of the *Prospectivae libri sex* (1600). Starting his studies from Com-

[1]Cf. P. Riccardi, *Biblioteca matematica Italiana. Dalla origine della stampa ai primi anni del secolo XIX*, Milano, Görlich, 1952.

[2]D. Mögling, *Mechanischer Kunst-Kammer erster Theil von Wag, Hebel, Scheiben, Haspel, Keil und Schrauffenwerckh*, Frankfurt, Merian, 1629. In reality, the *Mechanischer Kunst-Kammer* constitutes more than just a German translation of the *Mechanicorum Liber*; it further comprises a translation of the *Quaestiones Mechanicae*, excerpts of Euclid's *Elements* and parts of Walter Ryff's *Von rechtem Verstandt, Wag und Gewicht*. For further information on Mögling's treatise, cf. M. Poppow, *Court mathematicians, Rosicrucians, and engineering experts. The German translation of Guidobaldo dal Monte's* Mechanicorum Liber *by Daniel Mögling (1629)*, in "Guidobaldo del Monte (1545-1607). "Mathematics" and technics from Urbino to Europe", ed. by A. Becchi, D. Bertoloni Meli, E. Gamba, Berlin, Edition Open Access, 2012.

[3]For information about García de Céspedes's work, cf. V. Navarro-Bretons, *Mechanics in Spain at the End of the 16th Century and the Madrid Academy of Mathematics*, in "Mechanics and Natural Philosophy Before the Scientific Revolution", ed. by W.R. Laird und S. Roux, New York, Springer, 2008.

[4]R. Gatto, *La meccanica a Napoli ai tempi di Galileo*, Napoli, Città del Sole, 1996.

[5]The complete title reads: *Guidiubaldi e Marchionibus Montis, Planisphaeriorum Universalium Theorica*. The information about the re-edition is given by R. Sinisgalli, S. Vastola, *La Teoria sui Planisferi Universali di Guidobaldo Del Monte*, Firenze, Cadmo, 1994. Riccardi's *Biblioteca matematica Italiana*, cit., does not report this information.

mandino's reflections on this topic,[1] Guidobaldo achieved in these two works a theoretical synthesis and mathematical model of empirical approaches already used by famous Urbinate painters and architects like Bramante, Raffaello and Piero della Francesca regarding perspective mappings.
Guidobaldo's treatise of 1579 is subdivided in two books and is dedicated to the explication of various types of planispheres.[2] In the first book, he attends to comment on Gemma Frisius's planisphere furnishing geometrical demonstrations of what had remained unproven by the Dutch mathematician. Furthermore, he gave the necessary indications to construct the described device. In the second book, the Marchigian mathematician approached the analysis of the planisphere of Juan De Rojas, considered the inventor of the universal astrolabe. As the projection exposed by the Spanish mathematician refers to a point of observation in infinite distance, his planisphere pones problems relative to orthographic projection. Guidobaldo addressed himself to the topic with the usual mathematical rigour, *inter alia* proving that the section of a cylinder and a plane (not parallel to the axis of the cylinder) is generally an ellipse – a fact unknown both to De Rojas and to Frisius. Here, again, he exposed a scientific instrument appropriate to draw ellipses, with a clear and detailed theoretical justification. This fact confirms Guidobaldo's interest in the practical aspects connected with mathematics, besides his unquestioned skill to present theorisations of mathematical fields.[3]

The extant documentation suggests that Guidobaldo was passing a scientifically rather fertile period, without relevant distractions from his studies. So, in a letter to Giulio Giordani of July 14th 1579, he claimed to have written the *Planisphaeriorum Universalium Theorica* "in order to pass the leisure".[4]

[1] An interesting study on Guidobaldo's initial orientation towards Commandino's studies, contained in *In Ptolemaei Planisphaerium Commentarius* (1558), is P. Marchi, *L'invenzione del punto di fuga nell'opera prospettiva di Guidobaldo dal Monte*, Tesi di Laurea, Università degli Studi di Pisa, 1998.

[2] Planispheres had the function to represent in the plane the celestial sphere with all his significant circles – a procedure that obviously posed problems relative to stereographic or orthogonal projection, according to the type of planisphere. Fundamental for their construction were the empirical guidelines given in Ptolemy's *Planisphaerium*. A different way of stereographic projection had been found by Gemma Frisius, exposed in *De astrolabio catholico* (1556), by assuming the centre of projection on the equinoctial circle, while in Ptolemy it was fixed in one of the two poles. The advantage of this method consisted in the possibility to adapt the planisphere to an arbitrary latitude (for that reason it was called "universal"), while Ptolemy's was valid only for a specific horizon.

[3] For further information about the *Planisphaeriorum Universalium Theorica*, cf. R. Sinisgalli, S. Vastola, *La Teoria sui Planisferi*, cit. For hints at his invention and occupation of/with scientific instruments, cf. Part A, IV.1.1.

[4] Cf. BOP, ms 426, fol. 151r: "Ho caro di aver fatto quest'altro libro per aver occasione di romper un poco il nostro silentio. Per passar l'otio mi son messo a far quest'altra fatica. La cosa è assai specolativa, ma se ben debole, so che V.S. come cosa mia l'accettarà volentieri (...) ." For the transcription of the entire letter, cf. Appendix I, I.2.1.

In 1580, Pope Gregory XIII contacted Francesco Maria II asking the opinion of the mathematicians in his services about the reformation of the calendar. J. Mazzoni, who was dwelling in Rome on the Pope's invitation, had brought Guidobaldo into play as a letter to the Duke's secretary Giulio Veterani reveals.[1] So, at the Duke's instance, the Marchigian mathematician went about writing the *De Ecclesiastici Calendarii Restitutione Opusculum* (1580),[2] recommending to cancel ten days in October in order to restore the congruence between calendar and the real going of the seasons, as provided also in the proposal realised in the end.
The Duke's letter accompanying Guidobaldo's treatise to Rome for Pope Gregory XIII states that Guidobaldo "has done what was possible considering his poor health" – a notable confirmation of the information about his precarious state of health.[3] In fact, these problems were connected with the sciatica suffered in 1571 which would not have ever abandoned Guidobaldo for all his life.[4]
Despite of his poor health he dedicated considerable time and efforts to Pigafetta and his attempts to translate the *Mechanicorum Liber* – Guidobaldo was monitoring this translation process very closely, because many technical expressions had no Italian, linguistically consolidated analogy that went beyond a regional, dialectical use. So he himself suggested Pigafetta the Italian notions of many technical expressions not yet existing at that time.[5] *Le Mechaniche* were then released in 1581.

As far as the early and middle eighties are concerned, some more information about Guidobaldo and his work has survived, illustrating different aspects of his activities: partly in the capacity of architect, partly in that of a scholar, then again as one of the most important members of the ducal court. The sources further suggest that Guidobaldo passed a scientifically rather fertile period also

[1] Apparently, the Duke had not answered to the prior Papal bull that called on the catholic sovereigns to make proposals for the necessary modification of the calendar. Mazzoni mentioned the amazement in the Vatican environment caused by this silence and hinted at Guidobaldo as perfectly able to answer the Pope's expectation. For relevant sources in regard, cf. BOP, ms 443, fol. 50r and BOP, ms 430, fol. 199r/v; cf. Appendix I, I.3.1.

[2] The complete title reads: *Guidi Ubaldi e Marchionibus Montis, De Ecclesiastici Calendarii Restitutione Opusculum.*

[3] Cf. BOP, ms 458; see Appendix I, I.3.1.

[4] In fact, in the above cited letter (cf. Appendix I, I.2.1) to Giulio Giordani (July 1579) Guidobaldo states to be just about to go to the baths in Padua, and we know that these bath-stays served to cure the sciatica (cf. BOP, ms 758). Plausibly, the grave consequences resulting from the consumption of thermal water, which limited him "long time to his bed" according to BOP, ms 758, had manifested precisely in this period.

[5] The letters between Guidobaldo and Pigafetta on the translation of the *Mechanicorum Liber* are conserved at the Biblioteca Ambrosiana in Milan, R121sup and D34inf. An analysis of this translation process is contained in E. Calchini, *Guidobaldo del Monte e Filippo Pigafetta. Formazione del linguaggio tecnico in volgare nel XVI secolo*, Master-thesis, Università Pisa, 1982; and N. Castagné, *Les mots des sciences: la prose scientifique en langue vulgaire dans l'Italie du XVIe siècle*, Ph.D-thesis, Université Paris 8 and Università di Torino, 2012.

in these years. He gathered around himself – now at the latest, maybe already shortly after Commandino's death – a group of noblemen of the Duchy, scholars of mechanics, philosophy, literature, history, theology with whom he held frequent discussions about mathematics and philosophy – a fact not without consequences for his work.[1]

Simultaneously to his studies, Guidobaldo had to fulfil his duties towards the Duke, as several documents stemming from the year 1583 testify. A series of letters documents how the Duke's intimate Count Giovanni de' Tommasi and the architect Girolamo Arduini discussed about a mechanical clock that had to be constructed at the Duke's instance – with Guidobaldo controlling the functionality of the make, plausibly on the basis of his studies on sundials and his technical abilities. This fact illustrates the embedding of Guidobaldo's scientific work in its socio-cultural and political context of the Duchy of Urbino: "homemade" clocks, objects of remarkable prestige in those times, represented a notable diplomatic instrument to favour interactions with political opponents,[2] and Guidobaldo assumed a crucial role in the fabrication process.

Also the first certain notices about Guidobaldo's activity as civil architect go back to 1583, regarding works at the ducal Villa Miralfiore he had to supervise: there were problems with the water supply of a projected fountain in its park. Months of discussion between the person in charge Count de' Tommasi, architect Arduini and the superintendent of the construction site mastro Lazzaro had not brought a definitive solution.[3] In the end, Guidobaldo was approached for an expert's report on the hydraulic problem; an extant letter to Count de' Tommasi informs us about his on-site inspections and the proposed solutions.[4]

Possibly because of some courtly intrigues, in the following year Count de' Tommasi was put in prison.[5] A letter written by Ranieri dal Monte to the Duke reveals

[1]For general information about Guidobaldo's cultural environment, cf. Part A, chapter II. The problem about concrete influences on his scientific work is approached in Part A, IV.1.2, V.1, V.2.4 and Part B, I.3.

[2]Urbino with its clockmakers and the office of precision instruments was a national and international centre of the fabrication of mechanical clocks. Remarkably, the Urbinate diplomacy seems to have regularly had recourse to the option of presenting clocks as a gift in diplomatic relations. An article on this topic is forthcoming, cf. footnote 4 on page 36. As illustration, cf. the following letter from Francesco Maria dal Monte to the Duke of Urbino (ASF, Ducato di Urbino, Classe I, 126, fol. 851r; 1586): "The Cardinal de' Medici has commissioned me to kiss Your Highness' hand in his name for the favour You have done him bestowing the clock upon him. He assures You that You could not donate him anything that would have pleased him more, nor that he wished more than this and that he will remain perpetually obliged. (..) he promised me to take up the cudgels in the affair Your Highness knows."

[3]Regarding the interest development of these construction works, cf. BOP, ms 434. In Appendix I, I.3.2 the most relevant letters in regard are exposed.

[4]Cf. BOP, ms 426, fol. 155r/v (September 30th 1583); see Appendix I, I.3.2.

[5]The feudatory of Montebello had once been one of Francesco Maria II's closest intimates, then, yet, there seems to have been a confrontation with Count Giulio Cesare Mamiani, the Duke's favourite, ending with his detention and two years later even with his execution.

that both Guidobaldo and his father were assigned to arrest Count de' Tommasi.[1] In this document reporting the effected capture, Ranieri assured Francesco Maria II of the unconditioned loyalty of his family.
In 1585, Guidobaldo is said to have undertaken some trips outside Italy.[2] This might be related to the notice, which does not seems completely unfounded, even if surprising, that he is said to have been nobleman of Spain and to have been honoured by an important French decoration.[3] A possible confirmation of this information would entail interesting consequences for Guidobaldo's formation.
Anyway, Ranieri's son seems to have worked on several writings in the eighties: in fact, in a letter to Pier Matteo Giordani,[4] Bernardino Baldi – in the meantime in Guastalla and only sporadically guest in Pesaro – asked with curiosity if Guidobaldo was about to publish "one of his respectable writings".[5] Among them, there surely was the *Paraphrasis*, and presumably first drafts on the *Cochlea* and on some of his unpublished writings like *De Motu Terrae*.[6]

In 1586, the probably first tensions arose between the Duke and the dal Monte house, which later would have had serious consequences also for Guidobaldo: in occasion of the death of Pesaro's bishop in February, the Duke of Urbino offered Francesco Maria dal Monte to propose him for this function.[7]

[1]Cf. ASF, Ducato di Urbino, Classe I, 259, fol. 159r; see Appendix I, I.3.4.

[2]It is an anonymous source, probably stemming from the nineteenth century, which describes Guidobaldo's life, conserved at the Biblioteca Comunale Forlì, Coll. Piancastelli, Busta 19, Secc. XII-XVIII: therein, the Marchigian mathematician is said to have undertaken journeys in Europe in 1585. The source has some affinity to Guidobaldo's biography contained in P. Litta, *Famiglie celebri italiane*, cit.; cf. Appendix I, II.5.

[3]This information is contained in G. Mamiani, *Elogi storici di Federico Commandino, G. Ubaldo del Monte, Giulio Carlo Fagnani, letti all'Accademia pesarese dal Conte Giuseppe Mamiani*, Pesaro, Nobili, 1828; see Appendix I, II.3. It seems advisable not to underestimate the reliability of this information, since Mamiani refers, cf. note 41 in regard, to original letters found in the Archive of the Family dal Monte – now lost, as it seems – by a certain Teofilio Betti.

[4]Pier Matteo Giordano was Guidobaldo's closest scientific interlocutor and friend. For further information, cf. Part A, II.3, IV.1.2 and V.1.2. For biographical information on Pier Matteo Giordani, as well as on other scientific interlocutors and technical collaborators of Guidobaldo, cf. Appendix II, II.1.

[5]Cf. BOP, ms 430 fols. 27r-28v (June 6th 1585): "Desidero che mi dia qualche nova di sé e de' studi suoi, e se il S.r Guidobaldo è per dar in luce qualche onorata fatica delle sue."

[6]Essential for the understanding of Guidobaldo's work on various writings in the eighties seems to be a better comprehension of the *Meditatiunculae*. In-depth studies on them would be *desideratum*, and even more urgent in this regard, if the hypothesis about an "early" drafting of the manuscript (i.e. before the standard dating of ca. 1586-1593) would be true; cf. Part A, chapter VI.

[7]This gesture can surely be understood as expression of the Duke's gratitude towards the dal Monte family, but also as a political move: Francesco Maria dal Monte, abbot of S. Croce in Monte Fabali from 1563, he was residing at Rome from the early seventies and, representing the Urbinate interests in the Vatican ambiance, had become a good connoisseur of the Roman Curia, with an apparent giftedness in diplomatic affairs. A promotion to the function as bishop would

The latter, however, showed little interest in the offer, probably preferring to stay close by the Cardinal Ferdinando de' Medici, an influential member of the Curia.[1] This hardly grateful behaviour caused a serious annoyance to the Duke: several letters have survived in which Francesco Maria and his father Ranieri tried to calm the situation assuring that the former had the firm intention to maintain his duties towards the Duke:[2] even the Cardinal de' Medici intervened in the conflict, which permits to perceive its range. With all probability, Guidobaldo was included in these tentatives for a de-escalation as well. And in effect, stressing the devotion of the entire house versus the Duke, the dal Monte family apparently managed to re-establish the prior relations to Francesco Maria II della Rovere.

In January 1587, Ranieri dal Monte deceased. It was he, the popular head of the family, who had laid the foundations for the outstanding position of his family in the Duchy, thanks to his loyal and competent service particularly towards Duke Guidobaldo II, and afterwards to Francesco Maria II. Guidobaldo, his first born son, consequently succeeded him as the head of the family and second Count of Monte Baroccio. Comprehensively, this fact had ample implications for him since he had, from then on, responsibilities like the jurisdiction over his subjects, administrative duties or building activities in his *castello* Monte Baroccio.[3] Moreover, in February Guidobaldo was elected member of the Council of Pesaro at his father's place, according to the Duke's explicit recommendation.[4] Further, the responsibility to grant the brilliant relations towards the Duke now depended from him as the head of the family. This aspect can easily be underestimated, but seems in reality of decisive importance, considering the courtly *milieus* with their ploys and intrigues: in effect, Guidobaldo's relations to the Duke would have deteriorated. Anyway, the new situation after Ranieri's death, with its additional duties entailed a further distraction from his studies.
In that period, one of the pestering questions in the council was how to realise a new fountain at the central place of the city, to be constructed at the Duke's instance. Guidobaldo was elected, again following the Duke's recommendation,

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have surely increased his political authority and emphasised his connection to the Urbinate court. For further information on Francesco Maria dal Monte, cf. Appendix II, I.3 and Z. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, cit.

[1] Ferdinando would have become Grand Duke of Tuscany in 1587. The dal Monte family was closely connected with him, as the following account will show.

[2] For further information on this topic, cf. Appendix II, I.3.2.

[3] For information about Guidobaldo's various duties as count, cf. Appendix I, I.4.1 and G. Allegretti, *Monte Baroccio 1513-1799*, cit.

[4] Cf. the Council Records conserved at the ASCP (BOP), Atti del Consiglio 1580-1609, II C 1, fols. 64v-66r; see Appendix I, I.4.1. Some sources erroneously predate Guidobaldo's election to the year 1580. As an analysis of the Council Records shows, he was not among the most active members. In particular, he does not figure as *Confaloniere*, i.e. the presider of the council, in contrast to what claimed in P. Litta, *Famiglie celebri italiane*, cit.; see Appendix I, II.5.

the "responsible for the fountain".[1] But these works did not constitute the only task of Guidobaldo in the capacity of architect in the Duke's service: like four years before, he was commissioned to resolve problems connected with the water supply at Villa Miralfiore. This task was not independent from the works on the fountain, as letters between the Marchigian mathematician, Count Giulio Cesare Mamiani and G. Arduini evidence.[2] On top of that, a letter of Guidobaldo hints to another project apparently supervised for the Duke's sake: in August, he wrote to the Duke's first secretary Giulio Veterani: "This letter of mine is supposed to inform you that the works at the port have been begun".[3]
Not only Guidobaldo's activity as architect, but his very scientific work was conditioned by the Duke's requests, as well: in 1587, Guidobaldo had not only to revise Commandino's incomplete translation of the Pappian *Collectiones Mathematicae* at Francesco Maria II's instance – a task that implicated the comparison of his teacher's drafts with other Greek manuscripts from Rome.[4] The analysis of his correspondence shows that he moreover had to compose a treatise on clocks for the Duke.[5]

The year 1588 was something like Guidobaldo's *annus mirabilis*, given the happening of several crucial events then. On the first days of January he got to

[1]He was elected with other collaborators who seem to have attended, though, rather to administrative problems relative to the construction of the fountain, as the Council Records reveal. For a collection of relevant documents in regard, cf. Appendix I, I.4.1.

[2]Also in this regard, cf. the documents in Appendix I, I.4.1.

[3]Cf. BOP, ms 426, fol. 157r; see Appendix I, I.4.1. This passage suggests that Guidobaldo was in some form responsible for this construction project: otherwise it is hardly imaginable that he was able to inform the Duke's secretary about works at the port of Pesaro. The latter was object of frequent maintenance and modification operations: there were building projects also in the fifties of the sixteenth century. Then, in the second decade of the seventeenth century, even ampler works were realised: The involvement in these works of two figures from Guidobaldo's vicinity, his disciple N. Sabbatini and his son Francesco Maria (II) dal Monte, might be a hint at the former's role in rebuilding the port at the end of the sixteenth century. In-depth researches on this topic would be welcome, for they could furnish interesting details on this type of Guidobaldo's activities. For further informations on the history of the port of Pesaro, cf. G. Pedrocco (editor), *Immagini e storia del porto di Pesaro*, La Pieve, Verucchio, 1986.

[4]The translation from Greek into Latin had already been initiated by Commandino, but shortly before its publication the Urbinate scholar had passed away. After ten years without progresses, the task to complete the work first was assigned to Francesco Barozzi, then he was replaced by Guidobaldo. Although the latter's name does not appear in the edition, we can be sure of his involvement in the final revision, thanks to a letter written to Giulio Veterani and to Baldi's *Vita di Commandino*; cf. Appendix I, I.4.1. A detailed study of the surprising background of this edition regarding Francesco Barozzi's involvement, is contained in L. Passalacqua, *Le "Collezioni" di Pappo: polemiche editoriali e circolazione di manoscritti nella corrispondenza di Francesco Barozzi con il Duca di Urbino*, in "Bollettino di Storia delle Scienze Matematiche", XIV 1 (1994), pp. 91-156.

[5]Cf. BOP, ms 211, fol. 102 r/v (July 1st 1587); see Appendix I, I.4.1.

know, by letter, the young Galileo who had contacted him as well as other famous mathematicians, Christoph Clavius and Giuseppe Moleti. In his letter, the Tuscan mathematician had apparently asked Guidobaldo's opinion about some theorems on three-dimensional *baricentrica*-theory he had found.[1] The Count of Monte Baroccio answered on January 16th praising the "exquisite and profound science and a very nice, succinct and short way of arguing" of Galileo's theorems in an almost enthusiastic way. Guidobaldo was the first one of the "foremost" representatives of the mathematical world to recognise Galileo's talent. He admired especially Galileo's imitation of the Archimedean prove technique and assured the young Pisan scholar to have found, in his person, someone who "in all Your necessities will not leave out occasion to serve You." In effect, Guidobaldo's cordial offer was no empty promise: in the following years he supported Galileo in several occasions and ways, both personally as well as by his excellent connections. Moreover, not very much later their acquaintance evolved in friendship and a reciprocal scientific collaboration.[2]

Few weeks afterwards, Guidobaldo published his *Paraphrasis* – he used the occasion to send a copy to Galileo – on the Archimedean *Equilibrium of Planes*, the Syracusan's main extant work on mechanics. As fundamental the latter text was for the evolution of mechanics, so problematic it was from conceptual, technical, philological points of view. Guidobaldo, in contrast to the two earlier printed editions of the text,[3] succeeded in elaborating a reliable and exigent comment on the *Equilibrium of Planes*, as Part A, chapter V will document. The edition of this book completed, to a certain extent, Commandino's work,[4] making accessible another treatise composed by the Syracusan mathematician.

Yet, this seems not to have been the only goal Guidobaldo had pursued: as an in-depth analysis evidences, he intended, as well, to defend his theory of indifferent equilibrium, presented eleven years before in the *Mechanicorum Liber*.[5] Moreover, he apparently used the opportunity to expose some reflections of philosophical character relative to mechanics, which he had probably developed in the context of the discussions in his philosophical-mathematical circle.[6]

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[1] Galileo's letter itself is not any more extant, but its content can be partly reconstructed on the basis of Guidobaldo's preserved reply which dates from January 16th, cf. BNCF, ms Gal. 88, fol. 9r/v; published in Galileo, *Opere*, vol. X. Galileo had written to Clavius on January 8th, similarly regarding theorems on *baricentrica*.

[2] In Appendix I, I.4.2, the first letters between Guidobaldo and Galileo are reported.

[3] The first printed version of the text was edited by Tartaglia in 1543, the other one was contained in the *Editio princeps* of Archimedes's works (Basel; Venatorius; 1544). Both of them could not resolve the problems inherent to the Archimedean writing in its transmitted form.

[4] In the *Archimedis Opera Nonnulla*, Commandino had published in 1558 the Latin translations of the following Archimedean treatises: *Circuli Dimensio*, *Liber de Lineis Spiralibus*, *Quadratura Paraboles*, *Liber de Conoidibus et Sphaeroidibus* and *Liber de Arenae Numero*. In 1565, he edited the translation of another Archimedean work, the *On Floating Bodies*. The *Equilibrium of Planes* had in contrast not been edited by Commandino.

[5] Cf. Part A, chapter V and Part B, I.

[6] Cf. Part A, section V.1 and subsection V.2.4.

Again in 1588, Guidobaldo finished the works on Pappus's *Collectiones mathematicae*, so that they could appear in the same year. It was a fundamental compilation of ancient mathematics, important not only for the evolution of mechanics (treated in their eighth book) but also of mathematics.[1]
Yet, already in the same year, Guidobaldo must have felt perceptibly diminish the time for his studies: to Galileo he complained about the confusion his staying "out" for a long time; to Federico Bonaventura[2] he confessed that many things detracted him from his studies.[3] This discontent is not surprising: the numerous duties for the Duke, his occupations relative to his county and his role as the head of an influential family had changed profoundly the situation of only one decade before.
Still in 1588, Guidobaldo was appointed *Visitatore* of the Tuscan fortresses by Grand Duke Ferdinando I whose closest intimate in that period was exactly his brother Francesco Maria dal Monte.[4] This nomination testimonies on the one hand the excellent relations between the dal Monte house and the Medici, and on the other Guidobaldo's reputation in questions connected with military architecture. The precise time of Guidobaldo's activity in Tuscany – interesting also because of possible occasions for personal meetings with Galileo – still is uncertain: as a recent study shows,[5] the Marchigian mathematician controlled some Tuscan castles in the summer of '89. Yet, it is unclear if he went in Tuscany also in 1588.[6]

[1]Especially the seventh book was important for the evolution of modern mathematics: it was a problem posed by Pappus which occupied Descartes at the beginning of his *Geométrie* and whose solution marked a crucial step in the Cartesian mathematics.

[2]F. Bonaventura was an Aristotelian philosopher, something like the "court philosopher" of Francesco Maria II. He was one of Guidobaldo's scientific-philosophical interlocutors, cf. Part A, section V.1. For information about Bonaventura's biography and work, cf. Appendix II, II.1.

[3]Guidobaldo to Galileo (BNCF, ms Gal. 88, fol. 22r; September 16th 1588): " (...) Ma lei e tanto cortese verso di me che non voglio mancare, ma non posso adesso perche l'ho fra certe certe mie carte, che Dio sa dove sono per haver assai scombossolato il mio studio, essend'io stato fuori, dove mi bisognara forse tornare."
Guidobaldo to F. Bonaventura (BCF, Autografi Piancastelli, 755; December 8th 1588): " (...) Ho voluto dirGli questo perché non volevo star più a risponderLe, ma io veramente non ho ben considerato ogni cosa, che appena ho letto il Cisalpino in quel luogo così alla sfuggita, avend'io molte cose che mi levano lo studiare, V.S. le considerarà meglio di me."

[4]Cf. in this regard Appendix II, I.3 and Z. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, cit.

[5]Cf. F. Menchetti, *Guidobaldo del Monte nel Granducato di Toscana e la scuola roveresca di architettura militare*, in A. Becchi, D. Bertoloni Meli, E. Gamba, *Guidobaldo del Monte (1545-1607). "Mathematics" e technics from Urbino to Europe*, Proceedings of the conference "400^o Anniversario della morte di Guidobaldo del Monte" Urbino-Mombaroccio June 15th-16th 2007, Berlin, Edition Open Access, 2012.

[6]A letter from Guidobaldo to the Grand Duke, written in June, is not clear about this point, cf. ASF, Mediceo del Principato, 798, fol. 795r; see Appendix I, I.4.2. BOP, ms 758 (Appendix I, II.2) reports a trip of Guidobaldo in 1588, but not the one in 1589. A simple lapse? A

In gratitude for "many and many favours Your Highness offers to our house" he sent his son Orazio at Ferdinando I's service: he became *Governatore* of the Pisan fortress and *Generale dell'Arme* of the State of Pisa.[1] As if this honour had not been enough, another member of the dal Monte family reached an even more prestigious function by influence of Ferdinando I: Francesco Maria dal Monte, Guidobaldo's brother, was made cardinal by the philo-Medicean Pope Sixtus V, in December 1588.[2]
The lists of the Duke of Urbino's annual grants for the members of his "*famiglia*" – a sort of payrolls – reveal Guidobaldo's extremely high standing in the hierarchy of the court: from 1586 until 1589,[3] he is listed under the first five and best paid courtiers. Generally, with Ranieri (before his death in 1587) and Francesco Maria dal Monte at the Duke's service, the dal Monte family turns out to have been the most important family of the court in those times.[4]

In April 1589, Guidobaldo was invited to the wedding between Grand Duke Ferdinando I and Christina of Lorraine in Florence,[5] which offered the occasion for a little family reunion: besides him, also his brother cardinal and his son

possible period, as a chronological gap in his correspondence shows, could have been from end of March until the end of May or from the middle of August to the middle of September. In effect, in the aforesaid letter to Galileo of September 16th 1588 (BNCF, ms Gal. 88, fol. 22r), Guidobaldo writes to have passed many time "out" (cf. footnote 3 of page 48). Then, also in 1590 Guidobaldo turned in Tuscany, see below.

[1]Cf. ASF, Guardaroba medicea Diari di etichetta, 1; see Appendix I, I.4.3. Orazio's service, to which Guidobaldo's letter to the Grand Duke hints, does not refer to his function as donzel at the Florentine court, as sometimes claimed. He occupied this task around the year 1592, cf. Appendix II, **??**.

[2]The Florentine court was in this way compensated for Ferdinando I's retirement as cardinal in 1587, when his brother Grand Duke Francesco I had died and he had consequently succeeded him to the throne. Guidobaldo's brother would have become an influential cardinal – he formed, with Cardinal Montalto, the mightiest representative of the Medicean interests at the Roman Curia and was counted, at the conclaves in 1621 and 1623, under the *papabili*, cf. ASF, Carte Strozziane, prima serie, 226; see Appendix II, I.3. In general, a cognition of Francesco Maria dal Monte's life favours to some extent a better comprehension of the happenings around Guidobaldo. The consultation of the sources in Appendix II, I.3 therefore is advisable. Further, cf. Z. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, cit.

[3]These are the only years in the eighties and nineties, unfortunately, for which the lists seem to have survived. The chronologically next payroll dates from the year 1600 – Guidobaldo at that time did not belong any more to the Duke's "family".

[4]In the hierarchically structured register, Guidobaldo is listed directly after the Duke's cousins (and sometimes after the bishop of Cagli), even before the Duke's intimate Giulio Cesare Mamiani, cf. Appendix I, I.4.4.

[5]Concerning this point, BOP, ms 758 mixes the date up: "L'altra <volta>, dal Granduca fu mandato a chiamare per le nozze acciò come caro a quell'A.za per averli allora fatto il fratello Cardinale intervenisse con lui e fu del 1590." But the wedding was in 1589 and we have Guidobaldo's own letters that report about that wedding.

Orazio were present, for their connections to the Medici court and administration.[1]
After the extensive marriage celebrations, Guidobaldo (re-?)commenced his inspections of Tuscan castles at Pisa, Leghorn and Grosseto, before he concluded his tour, after a stay at Florence in June,[2] at S. Martino and Terra del Sole, two castles close by the frontier to the duchy of Urbino, from where he turned home in July.[3]
Also for the Duke of Mantua Guidobaldo was working in the capacity of military architect, as from a recently discovered letter emerges. This emphasises Guidobaldo's reputation as military engineer: he must have been nationally noted for his abilities, beyond the native territory of the Duchy of Urbino and the dominion of the Medici to whom his family was closely related.[4]
Only several weeks later, the young Galileo obtained the professorship of mathematics in Pisa, thanks to the efforts of Guidobaldo and his brother. In effect, the Count answered to Galileo's letter in this occasion with his usual modesty: "I assure you that I wished to be able to serve you much more than I have done, since, considering your merits, I have the feeling to have not done anything".[5] Presumably, Guidobaldo or Francesco Maria had intervened personally with the Grand Duke during their Florentine sojourn, in order to obtain this professorship for Galileo.
As remarkable Guidobaldo's connections and services to other sovereigns were, so problematic for his relations to Francesco Maria II was his orientation away from the Urbino court, especially towards the Medicean one: in fact, the Duke is reported to have proved "enormous jealousy" in occasion of Guidobaldo's trips in Tuscany.[6] In effect, the strategy pursued by Guidobaldo as head of the dal

[1]For further information about the wedding between Ferdinando I and Christina of Lorraine, cf. J.M. Saslow, *The Medici Wedding of 1589. Florentine Festival as* Teatrum Mundi, New Haven London, Yale University Press, 1996; particularly chapter VI. For information about Guidobaldo in regard, cf. Appendix I, I.4.3.

[2]The information about his stay in the Tuscan capital – contained in a letter (ASM, busta 1117, fol. 496r; see Appendix I, I.4.3) – is important, since it implies the possibility of a first personal meeting between the Guidobaldo and Galileo: the latter was staying at Florence at that time, too, cf. M. Camerota, *Cronologia galileiana 1564-1642*, Firenze-Cagliari, Istituto e Museo di Storia della Scienza-Cuec, 2003. Given their reciprocal appreciation and the attempt already in 1588 to meet personally, a personal contact in June 1589 is by all means possible.

[3]In Appendix I, I.4.3, the route of Guidobaldo's trip in Tuscany is described in a more detailed way.

[4]It still remains unclear if the contact implicated an one-time consultation, or a relation of service similar to the one between Guidobaldo and the Grand Duke of Florence, with repeated inspections *in loco*. Notable, in this context, seems the Count of Montebaroccio's acquaintance with a remarkable number of sovereigns: apart from the Dukes of Urbino, Mantua and the Grand Duke of Tuscany he knew, with all probability, also the Duke of Parma Octavio Farnese to whom he had dedicated his *Planisphaeriorum Universalium Theorica*.

[5]Cf. BNCF, ms Gal. 88, fol. 28r (August 3rd 1589); published in Galileo, *Opere*, Vol. X.

[6]Cf. BOP 1009, "Abecedario degli architetti pesaresi" di D. Bonamini, pp. 60/61: "Nell'anno 1588 ebbe commissione dal Gran Duca di Toscana che gli aveva fatto far cardinale il // fratello

Monte family was not very prudent considering that in not more than four years (1586-89) three exponents of the dal Monte house (first Francesco Maria, then Guidobaldo and Orazio) had *de facto* entered in service of the Medici court whereas the two originators and guarantors of the excellent relations between the dal Monte house and the Dukes of Urbino had passed away (Ranieri in 1587 and Montino dal Monte in 1585). So, whatever might have been Guidobaldo's projects with this behaviour – possibly the desperate future prospects for the Duchy of Urbino with its forty-years old Francesco Maria II della Rovere without any hope for successors – the strategy of Guidobaldo and Francesco Maria, both childhood friends of the Duke, could be interpreted as a breach of confidence.[1] So it probably is with the year 1589 that the beginning increase of tensions between Guidobaldo and the Duke can be fixed which caused the former's falling in disgrace and, finally, his exilement.[2]

In 1589, a lawsuit took place against the masons of St. Maria degli Angeli in Pesaro that had crashed down: from the records of the case emerges that Guidobaldo was the architect of the church.[3] He was one of the witnesses and took side with the masons, affirming that the problem were the pre-existing foundations onto which he had been told to build the walls which had therefore taken up water.

Another document of the same year hints at an ulterior unknown facet of Guidobaldo's studies:[4] probably for administrative reasons, he had composed a writing in order to evidence that the Zoccolanti-Friars' church near Monte Baroccio was part of the diocese of Pesaro.[5]

Francesco Maria del Monte, di visitare tutte le fortezze dello stato e questa fu la cagione della fierissima gelosia colla quale lo vide poi Francesco Maria II suo signore, scacciandolo dalla corte assieme col primogenito di Guidubaldo." See Appendix I, II.4.

[1] In this regard, one should keep in mind that the relations between the della Rovere and the Medici were not the best ones: despite of the common goal to limit the influence of the Papal state in central Italy and the attempts to bring the two states closer that culminate in the marriage between Francesco Maria's unique son Federico Ubaldo and Claudia de' Medici in 1621, the mistrust of the della Rovere towards the greater and mightier Tuscan state was not unjustified in remembrance of the period 1516-1521 in which the Medici had taken control over the Duchy of Urbino and their ambiguous behaviour in occasion of the Urbinate revolt in the winter of 1572/73.

[2] There might have been, though, also other reasons for the tensions. We know, for example, that the Cardinal dal Monte caused a serious annoyance to the Duke when he renounced to continue to carry the insignia of the della Rovere. Anyway, besides the search of the reasons, a statistic shows that Guidobaldo did not mainly dwell any more, from 1589, at Pesaro, but at Monte Baroccio. For a more detailed account on this topic, cf. Appendix I, I.5.

[3] Cf. BOP, ms 1841; see Appendix I, I.4.3. The suit was held in November-December, filed by the Camaldolese Order against Giovan Antonio Zandrini and his sons and had to clarify to whose responsibility the collapse had to be led back.

[4] Cf. BOP, ms 443, fol. 70v, see Appendix I, I.4.3.

[5] The writing itself seems lost, but is listed in the register of the ducal office, to which BOP, ms 443 belongs. Interestingly in this context, the records of the Council of Monte Baroccio show that the friars approached Guidobaldo's town several times for financial support between 1600 and 1607.

At the beginning of 1590, he returned in Tuscany having been called by a letter from the Grand Duke himself to the Duke of Urbino.[1] Presumably, he inspected the working he had commissioned there before: the records of the Medici administration state that "Sir Guido Baldo del Monte has arrived in Leghorn on January 12th, has been accommodated in the castle, (...) and has left on February 9th with one of our litters".[2] This means that Guidobaldo had arrived at Leghorn two days after the first stone laying, and monitored the works from the earliest beginnings, for almost a whole month – this gives us an idea of the relevance of his contribution.[3] Further details on this trip are still unknown, but Guidobaldo possibly turned to Pesaro only several weeks after.[4]

In this period, Guidobaldo had already recommenced to search a new position for the Tuscan mathematician who was not feeling very comfortable at Pisa. The Count of Monte Baroccio had explored, thanks to his excellent connections to the scientific and political environment of the Venetian Republic, possibilities regarding a new appointment for the young Galileo. In contrast, the situation in Bologna did not seem promising for Galileo, for Magini's occupation of the chair of mathematics.[5]

Little is known about Guidobaldo's studies in this period: he certainly was attending to the *Cochlea*.[6] Probably he was engaged in studies on perspective, as well.[7]

Generally, Guidobaldo seems to have been interested in religious-theological questions, too: Baldi certified in his *Cronica* that Guidobaldo had "good cognition of (..) theology" – he further was, according to BOP, ms 758, author of treatises on the *Pater noster* and the *Ave Maria*.

[1]Cf. ASF, Ducato di Urbino, I, 236, fol. 291r; see Appendix I, I.6.1.

[2]Cf. ASF, Diari di Etichetta, 3, p. 27: "Sig.r Guido Baldo dal Monte arrivò in Livorno alli 12 di gennaro, fu alloggiato in fortezza, servito in argento da staffieri, con un p iatto di suo tavolo, 4 bocche in tinello e 5 cavalli alle stalle; e partì il dì 9 de febraro con una nostra lettiga." See Appendix I, I.6.1. This passage has been published by M. Biagioli, *The social status of Italian mathematicians 1450-1600*, in "History of Science", XXVII (1989), pp. 41-95.

[3]The date of the first stone laying is the 10th of January 1590, cf. Appendix I, I.6.1. The fact that he arrived two days *after* the first stone laying seems difficult to explain: it is not impossible that Guidobaldo had (or was) scheduled to arrive at Leghorn on the 10th of January, but was delayed – the journey from Pesaro to Leghorn took several days in those time and could present notable difficulties. Anyway, the lateness of his arrival could be the reason for the lack of his name among the architects of the *Fortezza Nuova*: the quoted architects instead are V. Bonanni, B. Buontalenti, G. de' Medici, cf. Appendix I, I.6.1.

[4]The earliest *terminus ante quem* for his return is constituted by a letter written to Galileo on April 10th (BNCF, ms Gal. 16, fol. 9r/v; see Appendix I, I.6.1), telling that "passing at Bologna I have asked about <Giovanni Antonio> Magino". Plausibly he travelled trough the capital of the Emilia, where he had relatives, on his journey home from Tuscany. Further also his service to the Duke of Mantua should be kept in mind in this regard: possibly, he has made inspections also in that duchy before his return.

[5]This information about Magini and Guidobaldo's efforts are contained in the same letter to Galileo of April 10th 1590 (BNCF, ms Gal. 16, fol. 9r/v; see Appendix I, I.6.1).

[6]Cf. BNCF, ms Gal. 16, fol. 9r/v; see Appendix I, I.6.1).

[7]Again, crucial for an insight into Guidobaldo's scientific activity in this period are the *Meditatiunculae*, which were, to a good extent composed in the period comprising the years

In the meantime his relations to the Duke were continuously deteriorating. The probably first manifestation of frictions was about the marriage portion of Felice della Rovere, i.e. Guidobaldo's wife and Francesco Maria II's half sister. The controversy about a tidy sum of money that Guidobaldo demanded from the court seems to have already begun in summer 1588, followed by Guidobaldo's insistence in autumn 1589 which finally brought to the drastic step of a lawsuit against the court:[1] this measure testifies the in the meantime compromised relation towards the Duke. Unsurprisingly, the sentence of the *causa* in 1592 was to Guidobaldo's disadvantage.[2]

Further tensions arose in occasion of the planned marriage between a member of Guidobaldo's family and a daughter of Count Mamiani.[3] Francesco Maria II does not seem to have been very pleased about this project: Guidobaldo felt the necessity to express his displeasure about the disgust caused to the Duke, and the intention to regain his grace.[4] The fact that he had to recover the ducal grace is another eloquent clue of the bad relations to the Duke at that time. Significantly, from this period on Guidobaldo seems to have stayed more and more often at Monte Baroccio, as the signatures of his letters show.[5]

Several documents have survived, ranging from December 1590 to October 1593,[6] that testify a part of Guidobaldo's tasks in the capacity of Count of Monte Baroc-

from 1586 until 1593; cf. footnote 6 on page 44 and Part A, chapter VI.

[1]Cf. Guidobaldo's letter to Giulio Veterani, BOP, ms 426 fol. 161r (September 20th 1589); see Appendix I, I.5.

[2]Cf. BOP, ms 443 fol. 447v; see Appendix I, I.5.

[3]At the present state, it is unclear which male member of his family Guidobaldo wanted to marry with Count Mamiani's daughter who, on her part, is not known with name, either. The most informative source in regard is a letter (BOP, ms 425, fols. 139r-140v; November 1st 1602; cf. Appendix I, I.5) in which Alessandro Barignani stated to have been "sent many and many times to treat about Count of S. Agnolo's daughter's marriage" on behalf of Guidobaldo. Federigo dal Monte's frequent involvement in the negotiations might be a hint that it was he who was designated to be the bridegroom. Guidobaldo included in the negotiations, besides his brother and Alessandro Barignani, also his other brother Cardinal Francesco Maria, his close friend Pier Matteo Giordani and Giulio Veterani, his and his father's friend as well as the Duke's first secretary.

[4]Cf. BOP, ms 426, fol. 167r (Guidobaldo to G. Veterani; October 21st 1591): "(...) I am very sorry that Federigo <dal Monte's> second appearance was interpreted so badly, for if we knew that His Most Illustrious Highness could have taken so much offence, You can be sure that we would not have sent him, as our main intention is to recover the grace of His Highness." See Appendix I, I.5.2.

[5]The 16 extant letters written by Guidobaldo in the period from 1589 until 1598 are all underwritten at Monte Baroccio, except for the last two (signed in Pesaro in 1597 and 1598). This fact is in clear contrast to the years prior to 1589, cf. the statistics in Appendix I, I.5. It is this space of time Baldi refers to in his *Cronica*, finished in 1596, claiming that Guidobaldo lived retired at his feud (cf. Appendix I, II.1).

[6]The documents are conserved partly at the Archivio Storico Comune di Mombaroccio (ACM) and partly at the Biblioteca Oliveriana Pesaro (BOP). In this context, we like to warmly thank Luca Cangini who has communicated to me his recent discoveries at BOP. For the transcriptions of some of the deeds in question, cf. Appendix I, I.4.1.

cio.[1] The inhabitants of Monte Baroccio had to gain, for example, his *nihil obstat* for all kinds of sales of property – in regard, Guidobaldo had to control the declarations in hearings of witnesses.[2]
It is easy to understand that all these occupations and sorrows limited his ease for cultivating his studies. Moreover, his health suffered further setbacks.[3] In effect, in 1593 he complained to Galileo – what a difference to the period in which he had composed writings "in order to pass the leisure" – that "to be honest, I have so many occupations which do not leave me respire, and for these things <mathematical studies> one would have to be free from any inconvenience".[4]
Among these distractions there were also his efforts, started already in 1590 as exposed above, to have Galileo obtain the professorship at Padua in 1592. Guidobaldo's connections to important characters of the "scientific" and political life of the Venetian Republic, like Gian Vincenzo Pinelli, Giacomo Contarini or Giovanni Battista dal Monte, remarkably contributed to Galileo's assumption.[5]

Despite of Guidobaldo's difficult situation, with good probability can be supposed that one (or more?) scientifically fertile meeting(s) between Guidobaldo and Galileo took place in those years: they are said to have realised together "experiments" on the trajectory of projectiles, which would have constituted an important step in Galileo's studies on the law of falling bodies.[6]

[1] In some scientific contributions, Guidobaldo is inexactly called "Marquis" or "Marchese di Monte Baroccio". Yet, Guidobaldo was only *member* of the family "Marchesi di Monte Santa Maria". In fact, he has not ever signed with "Marchese del Monte"(which was admissible only for the head of the entire family of the "Marchesi di Monte Santa Maria"), but only with "dei Marchesi del Monte", which constitutes an important difference in those times' social-status-conception. As far as his feud is concerned, he was Count of Monte Baroccio, i.e. less than Marquis. Only his son Francesco Maria (II) was made Marquis of Monte Baroccio, in 1608.

[2] For further information see Appendix I, I.4.1.

[3] In a letter to Giulio Veterani (BOP, ms 426, fol. 173r/v; February 8th 1592) Guidobaldo complained: "Quanto poi a noi, non resta altro se non che V.S. ci favorisca di procurar in tutt'i modi che lo sposalitio non s'abbi da far prima che a questo autunno che viene, perché prima ci tornaria tanto e tanto scomodo che V.S. non se lo potria immaginare, l'aver noi questo duolo così fresco (...)." In another letter to Pier Matteo Giordani (BCF, Collezione Piancastelli, Secc. XII-XVIII, busta 19; September 3rd 1591) he claimed: "Le bacio le mani di tanti avvisi e mi scusi s'io non son più lungo, com'intenderà da messer Andrea per una doglia di schiena ch'io presi quel dì per andare a trovare il Vescovo."

[4] Cf. BNCF, ms Gal. 16, fol. 19r; published in Galileo, *Opere*, vol. X. See Appendix I, I.6.2.

[5] Guidobaldo stated in the aforesaid letter (BNCF, ms Gal. 16, fol. 19r) "to have not done anything" in this regard: "Quanto poi che mi vogli haver obligo del luogho di Padova, io non voglio per niente che me ne habbi obligo, non avendoci io fatto niente, ma il tutto lo dia al suo valore et al suo molto sapere." But this is a rhetorical phrase owed to his modesty, similar to the one used three years before, concerning Galileo's appointment in Pisa.

[6] This information goes back to Bonaventura Cavalieri, who, on his part, referred to what Muzio Oddi had told him years before (cf. BNCF, mss. Gal, P VI, T. XI, fols. 234-35; (September 21st 1632), published in Galileo, *Opere*, Vol. XIV). As convincingly argued in J. Renn, P. Damerow et *alii*, *Hunting the White Elephant*, preprint 97 (1998), Max-Planck-Institut für Wissenschaftsgeschichte Berlin, the meeting could have been on Galileo's journey to Venice in 1592. Even if until now no *direct* confirmation has been found for the veracity of this

While the information on Guidobaldo and his environment in earlier periods was scarce – with exception of the second half of the eighties -, from the middle of the nineties on it becomes almost vanishing.[1]
His scientific studies do not seem to have proceeded well in that period, as his few letters of this time reveal: in January he complained to Galileo that the works on the *Perspectivae Libri sex* were "half asleep and half awake (...). But I want to terminate it and now I am adjusting the beginning (...) and more than anything else I want then Your opinion".[2] Then in September, he informed Galileo that "in this winter I hope to finish it (...) I wish to get rid of it, since I cannot see it any more".[3] But Guidobaldo did not succeed in realising this project: only years after, in July 1598, he wrote to Clavius to "have attended to the *Perspectivae* and, as I have received many requests, I have finished it, and intend to have it printed soon".[4]
Furthermore, Guidobaldo was dedicating some of his time in 1597 to the instruction of his son Orazio in mathematics.[5] In fact, as he writes to Galileo, he had, "in one year that Orazio was staying here, introduced <him> a bit in mathematics". In the same letter he asked the Tuscan mathematician to see about the mathematical progresses of his son, given that the latter was going to stay at Padua like Galileo.[6]

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claim, there are hints to it: first of all, Guidobaldo was eager to meet with Galileo, as several invitations, contained in his letters, evidence. Further the last pages of the *Meditatiunculae* seem to testify a collaboration between both scholars, cf. R. Tassora, *Le Meditatiunculae de rebus mathematicis di Guidobaldo del Monte*, Tesi di Dottorato 2001, Università di Pisa. Yet, it is not excluded that Guidobaldo and Galileo met more than just one time.

[1]For the years 1594-1596, e.g., no single letter by/to Guidobaldo is conserved, and from 1593 to 1598 only four. Neither in other sources much information can be found about him in this time.

[2]Cf. BNCF, ms Gal. 16, fol. 19r; January 10th 1593; published in Galileo, *Opere*; cf. Appendix I, I.6.2: "La mia *Prospettiva* mezzo dorme e mezzo vegghia, (..) Pur la voglio finire, et hora sono atorno per accomodargli il principio, (...) e prima di ogn'altra cosa ci vorro poi il suo giuditio."

[3]Cf. BNCF, ms Gal. 88, fol. 32r; September 3rd 1593; published in Galileo, *Opere*; see Appendix I, I.6.2: "(...) mia *Prospettiva*, la quale in questo verno spero di finirla (...). Io desidero di levarmela dinanzi che non la posso più vedere."

[4]Cf. APUG ms. 530, fols. 188r-189v: "(...) ho atteso alla *Prospettiva*, che essendomene fatta molta istanza, l'ho finita con animo di stamparla presto." See Appendix I, I.8.4. A partial, translated version is exposed in Part B, I.4.4.

[5]Possibly, his sons Uguccione and Giovanni were instructed as well. We know from Guidobaldo's second last will, dating from 1607, that these three sons were interested, and probably also instructed, in mathematics. See Appendix I, I.6.5.

[6]Orazio was going to stay with Guidobaldo's relative Giovanni Battista dal Monte, so Guidobaldo asked Galileo to exhort his son to continue to occupy himself with mathematics: "Sono tanti giorni che io non ho avuto nuova di V.S., che ho caro questa occasione di Oratio mio figliuolo che se ne viene per star appresso al Signor Giovanni Battista dal Monte, di ricordarmeli che desidero di servirla, desiderando di aver nuova di Lei. In un anno che Oratio è stato qua, io l'ho introdotto un poco nelle mathematiche et desidero che V.S. l'esorti a voler attenderci, che ha assai buono ingegno e po' andar studiando da se alcune cose; e gli ho detto

In 1598/99, Guidobaldo's theory of indifferent equilibrium turned to be the topic of another scientific debate:[1] a Swedish Jesuit scholar, Botwid of Närke,[2] had approached to his former teacher Clavius, criticising the Marchigian mathematician's treatment of the isostatic balance and asking his opinion. The German Jesuit's forwarding of this critique to Guidobaldo, and the latter's polemically reply to Botwid, led to a highly interesting documentation of this debate: especially Guidobaldo's letter is extremely precious revealing some of the basic conceptions of his mechanics.[3] Then, in 1599, after a remarkable feedback in Guidobaldo's scientific environment,[4] the latter fabricated a balance proving the correctness of his theory and sent it to Madrid, probably at the Mathematical Academy of Madrid.[5]

Moreover, also at that period Guidobaldo was occupied with prestige building projects in Pesaro: in 1598, he was elected by the Council of Pesaro, with four other subsidiaries, to build two triumph arches: the occasion of this commission was Pope Clement VIII's passage through Pesaro, in connection with the devolution of the Duchy of Ferrara to the Pontifical State.[6] The Count of Montebaroccio is said to have invented a technical device that had unhinged the city gates of Pesaro shortly before the papal entry in town,[7] as symbol for the city's obeisance to the Pope, the overlord of the Duke of Urbino.

Then, in 1599, Guidobaldo was active as architect of the city residence of the

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che come trova qualche difficoltà, se ne venghi da V.S., che so che per amor mio lo favorirà di esser qualche volta maestro, che ogn'un di noi lo riceveremo per favore." Cf. BNCF, ms Gal. 16, fol. 25r, published in Galileo, *Opere*, vol. X.

[1] A detailed contextualisation of the Guidobaldo-Botwid-controversy and an in-depth analysis of the topic of indifferent equilibrium is exposed in Part B, I.

[2] At this time, Botwid of Närke was residing at Madrid and was a member of the Madrid Academy of Mathematics.

[3] For information about the whole debate, cf. Chr. Clavius, *Corrispondenza*, critical edition by U. Baldini and P.D. Napolitani, vols. 7, Pisa, Edizioni del Dipartimento di Matematica dell'Università di Pisa, 1992. For Guidobaldo's "Letter to the Goth", see Appendix I, I.8.4. A partial, translated version is exposed in Part B, I.4.4.

[4] Some of the folios preserved at BUU, Fondo del Comune, Buste 120-21 are testimonies of this debate; cf. Appendix I, I.8.4.

[5] Guidobaldo's had a opportune occasion for this dispatch: one of his scientific interlocutors, Count of Carpegna, was commissioned by the Duke of Urbino to fulfil a diplomatic mission of at the Spanish royal court, in occasion of Philip III's accession to the throne. For further information about the Mathematical Academy of Madrid, see V. Navarro Brotons, *Mechanics in Spain at the end of the 16th century and the Madrid Academy of Mathematics*, in *Mechanics and Natural Philosophy before the Scientific Revolution*, edited by W.R. Laird, S. Roux, New York, Springer, 2008.

[6] Relevant extracts of the Council Records concerning this question have been published in G.G. Scorza, *Pesaro fine secolo XVI. Clemente VIII e Francesco Maria II della Rovere*, Venezia, Marsilio, 1980. The most important one in regard is transcribed in Appendix I, I.6.3.

[7] This information is reported both by P. Litta, *Famiglie celebri italiane*, cit., cf. Appendix I, II.5.

Mamiani at Pesaro.[1] In the meantime, this family represented the most influential one of the ducal court at that time,[2] so Count Mamiani's choice of Guidobaldo as architect, despite of his problems with the Duke, is a sign for his unbroken reputation in the capacity of architect.
Guidobaldo seems to have resided mostly at Pesaro in the period from 1597 until 1602, probably exactly for these tasks.[3] Maybe this fact was connected, as well, with a short-term improvement of his relations with the Duke – yet, they did not turn as excellent as they were before the year 1589: the "*lista della famiglia*" of 1600 evidences that Guidobaldo was not any more considered as belonging to the Duke's "family". Moreover, his isolation, grown in the meantime, is documented in a report by Cardinal d'Este in 1599:[4] It terminates with the phrase: "About Sir Guidobaldo del Monte, his <Cardinal dal Monte's> brother: he is a great mathematician, has relatives, nephews, but nobody around him."

A year later, Guidobaldo finally published his last writing *Perspectivae Libri sex*.[5] It represents a milestone for the mathematisation of this branch of optics to such an extent that it is considered as the starting point of perspective as a geometrisised discipline:[6] in fact, Guidobaldo is regarded "to be the father of the mathematical theory of perspective (...) [and it is advisable to] pay considerable attention to his work".[7] His fundamental achievement in this context is the

[1]This building, still existing even if modified in some parts, nowadays is called *Palazzo Gradari* and is situated at Pesaro, Via Rossini 24, at a hundred meters distance to *Palazzo Ducale* and to *Palazzo Del Monte-Baldassini*; cf. also footnote 1 on page 32. This fact has been discovered and published by D. Trebbi, *Palazzo Gradari, già palazzo Mamiani della Rovere*, Senigallia, Futura Officine Grafiche, 2004.

[2]Cf. the "payrolls" in Appendix I, I.4.4

[3]Cf. the statistics of his letters in Appendix I, I.5

[4]Cf. ASF, Carte Strozziane, prima serie, 226. Cardinal d'Este's report describes "Clement VIII's court". Consequently, it dwells also on Cardinal Francesco Maria dal Monte, influential exponent of the Medici fraction. The last sentence of the paragraph is dedicated to his brother Guidobaldo. Plausibly, Cardinal d'Este's refers to the period of Clement VIII's sojourn at Pesaro in 1598.

[5]Significantly, the treatise is not dedicated to to the Duke, but to Guidobaldo's brother Cardinal dal Monte. With just one exception, the *Planisphaeriorum universalium Theorica*, he had priorly inscribed all his writings to Francesco Maria II della Rovere.

[6]Perspective was closely connected to the practical-technical environments of artists and architects. The transmission of the respective rules and techniques took place in the "*abacus*-schools" and workshops were they had been developed. Therefore, at the beginning perspective did not constitute a mathematical branch with a satisfactorily formalised theory. At the same time, the use of perspective rules by architects might explain Guidobaldo's notable interest in this topic: he himself regularly executed this profession. Coupled with his propensity to search geometrical models for various mathematical branches, and stimulated by Commandino's studies, this might have contributed to the theorising approach of perspective.

[7]Cf. K. Andersen, *The Geometry of an Art. The History of the mathematical Theory of Perspective from Alberti to Monge*, New York, Springer, 2007, which exposes detailed studies on the history of mechanics. As far as particularly the development of Guidobaldo's approach to perspective and its initial connection to Commandino's work is concerned, cf. P. Marchi,

theoretical formalisation of the concept *punctum concursus*, i.e. of the general *vanishing point*.
The work is subdivided in six books: the first is devoted to visual angles, apparent sizes and to perspective images of lines, while the second deals with the problem of throwing plane figures, situated in a ground plane into perspective – rather emblematic for Guidobaldo's general argumentative style is the fact that he presents more than twenty different methods for this problem. In book three, in contrast, he attends to the perspective images of certain three-dimensional figures. Orthogonal projections and the perspective images of circles are the topic of the forth book: its first part therefore revisits the topic he had already approached in the *Planisphaeriorum universalium theorica* twenty-one years before; the second one, in contrast, seems to be related to Commandino's work on the subject.[1] The fifth book deals with the shadow casted by objects upon a plane when the light source is located in a single point, where Guidobaldo develops a topic already approached by Albrecht Dürer in the special case of a cube. The Count extends the latter's attempt to polyhedra, cylinders, cones and spheres. Theatrical stage design, in contrast, constitutes the topic of the sixth book: in this context, it is opportune to recall Guidobaldo's frequent presence at courtly theatrical presentations, which might have awaken his theoretical interest in this subject.[2]
All in all, "what Guidobaldo achieved in *Perspectivae Libri sex* is really quite impressive. He realised that the key to understanding perspective constructions was to look at vanishing points. He also demonstrated that the mathematics inherited from the Greeks was sufficiently rich to provide a geometrical foundation of perspective. Finally he opened new paths in the theory of perspective. He was indeed the father of the mathematical theory of perspective".[3] These fundamental achievements are, however, somewhat submerged under many propositions, which do not seem to be strictly relevant for the argumentation line and distract some attention from the essential novelties of his treatment.

The deterioration of his relations to Francesco Maria II reached its peak in May 1602: Guidobaldo was exiled to his feud at Monte Baroccio. This event was connected with the banishment of the Duke's cousins Ippolito and Giuliano

L'invenzione del punto di fuga nell'opera prospettiva di Guidobaldo dal Monte, cit. An Italian translation is contained in R. Sinisgalli, *I sei libri della prospettiva di Guidobaldo dei marchesi Del Monte*, Roma, Bretschneider, 1984.

[1]Cf. P. Marchi, *L'invenzione del punto di fuga nell'opera prospettiva di Guidobaldo dal Monte*, Tesi di Laurea, Università degli Studi di Pisa, 1998.

[2]In a letter to Giulio Giordani (BOP, ms 426, fol. 149 r/v; February 6th 1579) speaks about an "eclogue" recited at the Count of Metola's house for which he himself composed the *moresche*, cf. Appendix I, I.2.3; further, think of his presence at the courtly carnival, cf. Appendix I, I.2.2. Surely impressive were also the festivities in occasion of the Medici wedding in Florence in 1589, cf. Appendix I, I.4.3.

[3]Cf. K. Andersen, *The Geometry of an Art*, cit., p. 262.

della Rovere from the court. The reason(s) and the triggering incident of this resounding event remain rather mysterious. The discovery of an autograph letter from the Duke to the Pope reveals that the three figures had tried to influence the administration and jurisdiction at Pesaro in the absence of Francesco Maria II.[1] Plausibly, however, this was more a pretence to remove *personae non gratae* than the true motivation.[2] Anyway, this verdict caused a real scandal: the Duke's cousins flew to Rome, approached to the Pope personally and the Duke felt the necessity to contact the Pope and the Grand Duke of Tuscany,[3] in order to justify his dramatical measures against the three noblemen who were esteemed both at the Florentine and Roman court. The respective, contemporary reports focus almost entirely on Ippolito's and Giuliano's role, while Guidobaldo seems a marginal person in this affair. It does not seem implausible that the Duke used the occasion of dal Monte's friendship to the della Rovere brothers in order to get rid of him as well, since his relation to the Duke, as exposed above, had continuously deteriorated.[4]

Consequently, Guidobaldo's isolation became even more intensive. Even if he maintained his epistolary contacts with Galileo, Clavius and Pier Matteo Giordani, the dissociation even by his closest friends, who feared to displease the Duke, is perceptible in the few conserved letters of that period: Giulio Giordani, the ducal secretary and friend of the dal Monte brothers from childhood on, did not ever express personally his condolences in occasion of the death of Guidobaldo's son Carlo,[5] Ludovico Agostini stresses his reluctance to know "more than it is

[1] Cf. ASF, Ducato di Urbino, I, 106, fols. 64r-65v; see Appendix I, I.5.4.

[2] More probable seems a scenario similar to the following: the Duke was aware of the discontent of the leading noble families caused by the lack of an heir to the throne, despite of his second marriage in 1598. This lack of heirs risked to lead – and would have led, in the end – to the devolution of the Duchy to the Pontifical State and, in consequence, to a probable loss of influence for the respective noble families. The Duke must have become even more distrustful as he already was by nature, when he got to know that during his frequent absences from Pesaro – Francesco Maria II was often residing at Casteldurante (Urbania) at that time; frequently, he was passing weeks and even months there, without visiting the two major cities of the Duchy, Urbino and Pesaro – his cousins Ippolito and Giuliano, who had notable political influence in the Duchy, and in their company the in the Duke's eyes disloyal Guidobaldo, took political and administrative decisions. To put an end to this situation, there might have been sufficient a minor occasion, and the Duke exiled the three noblemen.

[3] Cf. Appendix I, I.5.4.

[4] The eighteenth-century local historian Domenico Bonamini claims that Guidobaldo was put in prison in this context (cf. BOP, ms 966, "Cronica della Città di Pesaro", p. 160; see Appendix I, I.5.4); yet, this seems improbable considering a letter (cf. ASF, Mediceo del Principato, 911, fol. 14r/v; see Appendix I, I.5.4) written by Count Carpegna to the Grand Duke of Tuscany which emphasises Guidobaldo's prudent behaviour in this regard – in contrast to that of the Duke's cousins – having retired to his feud at Monte Baroccio.

[5] Cf. BOP, ms 923; letter to Pier Matteo Giordani of January 2th (letters of this archival unit without numeration, in chronological order); see Appendix I, I.5.4.

opportune to know" about the reasons of Guidobaldo's exilement,[1] while Pier Matteo Giordani, despite of maintaining his epistolary exchange with the Count of Monte Baroccio, seems to have refused the latter's invitations to visit him personally at his feud.[2]
It could seem an almost desperate attempt to gain the Grand Duke of Tuscany's support, when Guidobaldo offered some pictures to the Florentine court in summer-autumn 1602,[3] surely informed by his brother Cardinal about Ferdinando I's ambition to amplify his art collection. But the Grand Duke does not seem to have been able, or willing, to lobby for Guidobaldo, despite of the doubtless intervention by Cardinal dal Monte, in this context.[4]

In May 1605, in occasion of the birth of the long-desired heir Federico Ubaldo della Rovere,[5] the Duke decreed an amnesty for all criminals in the Duchy, and consequently Guidobaldo was pardoned, as well. The Count of Monte Baroccio, with his whole family, appeared among the first subjects to congratulate the Duke for this, seemingly, saving event for the Duchy.[6]
In March 1606, Guidobaldo fell ill another time, once again as consequence of his sciatica.[7] Nevertheless, he assumed responsibility in a political task: in order to assuage political differences between the cities Gubbio and Pesaro, several representatives were chosen at Pesaro to deal with this affair, amongst whom also Guidobaldo.[8]
In the same year, the lawsuit about Felice dal Monte's marriage portion was

[1]Cf. BOP, ms 193ter, fol. 87r (May 17th 1602), published in G. Montinaro in *L'epistolario di Ludovico Agostini. Riforma e utopia*, Firenze, Olschki, 2006; pp. 220-221.

[2]In occasion of the death of Guidobaldo's son Carlo, Pier Matteo confined himself to presenting the condolences by letter (cf. BOP, ms. 426, fol. 183r). Also the debate about the nova of 1604 between them took place by letters, not personally, cf. G. Arrighi, *Un grande scienziato italiano: Guidobaldo dal Monte in alcune carte inedite della Biblioteca Oliveriana di Pesaro*, in "Atti dell'Accademia Lucchese di Scienze, Lettere ed Arte", XII, Firenze, 1965.

[3]Cf. Z. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, cit.

[4]Ferdinando I seems to have supported Francesco Maria II's approach against disloyal subjects, as emerges from a letter written by the Duke of Urbino to Ferdinando I, cf. Appendix I, I.5.

[5]Federico Ubaldo lived from May 16th 1605 until June 28th 1623. So the hopes of the Duke's subjects for the possibility to avoid the devolution of the Duchy to the Pontifical State would have been dashed.

[6]A secretary of the Marquise del Vasto described the festivities in occasion of Federico Ubaldo's birth on May 16th 1605 (cf. BOP, ms 381, pp. 59-67); in this occasion, he mentions also Orazio, Guidobaldo and their family (p. 63): "in questo giorno [il 22 maggio] comparve il S.r Orazio del Monte arivato da Fiorenza, e tre giorni prima il S.r suo Padre e madre e fratelli con tutta la loro famiglia nobilissima." From this account emerges, moreover, that Guidobaldo was among the first to congratulate the Duke, on 19th of May.

[7]Cf. BOP, ms 758; see Appendix I, II.2.

[8]Cf. Council Records at BOP, Archivio Storico Comunale, Atti del Consiglio 1580-1609, II C 1, fols. 328v-331r; see Appendix I, I.6.4.

rolled up, probably for good: also this time, the sentence was in favour of the court and against Guidobaldo.[1]
At the beginning of November, Guidobaldo's state of health deteriorated drastically so that he became bedridden. The thermal water he had taken as remedy for the sciatica had provoked a serious gastro-intestinal disease, and even the elixirs sent by his brother Cardinal dal Monte were not having any positive effect.[2] After having dictated his last will on January 4th,[3] Guidobaldo passed away on January 6th 1607 in Pesaro.[4]

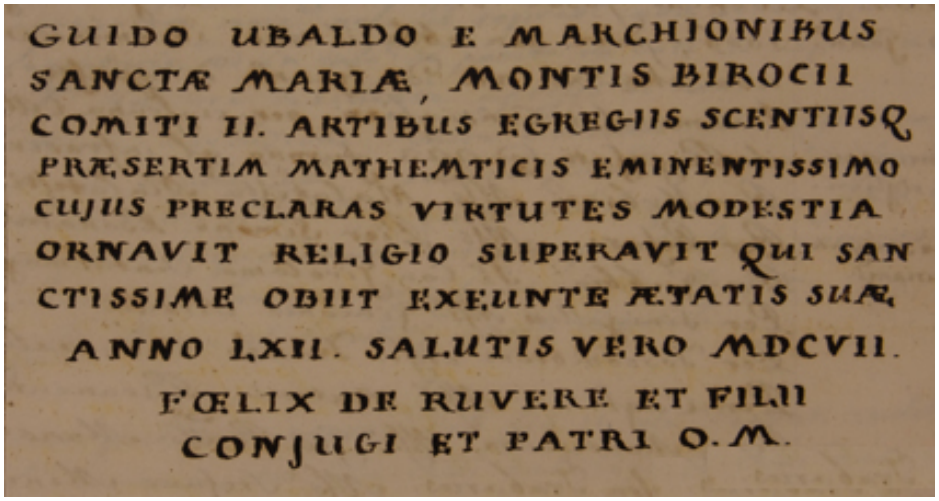
GUIDO UBALDO E MARCHIONIBUS
SANCTÆ MARIÆ, MONTIS BIROCII
COMITI II. ARTIBUS EGREGIIS SCENTIISQ
PRÆSERTIM MATHEMTICIS EMINENTISSIMO
CUJUS PRECLARAS VIRTUTES MODESTIA
ORNAVIT RELIGIO SUPERAVIT QUI SAN
CTISSIME OBIIT EXEUNTE ÆTATIS SUÆ
ANNO LXII. SALUTIS VERO MDCVII.
FŒLIX DE RUVERE ET FILII
CONJUGI ET PATRI O.M.

Figure I.6: Guidobaldo's epitaph in Bonamini's "*Cronica di Pesaro*"

Guidobaldo was buried in the church Santa Chiara of the monastery Corpus Domini at Pesaro;[5] even if it does not exist any more, the words of his epitaph have come down to us, cf. figure I.6.[6]

[1]Cf. BOP, ms 453, fols. 164r-167r; see Appendix I, I.5.

[2]Cf. BOP, ms 758; see Appendix I, II.2. This account is confirmed by the records of the Council of Monte Baroccio: the entry of November 26th, mentions Guidobaldo's disease, cf. Appendix I, I.6.4. For information on Francesco Maria dal Monte's pharmacological abilities, cf. Z. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, cit., vol. II, section III.2a.

[3]The recently discovered last wills of Guidobaldo are conserved at ASP, fondo Notarile, Vasconi Giovanni, anno 1597, III parte, busta 1732, fols. 240r-243v and busta 1732/1746, fols. 1v-5r; see their transcription in Appendix I, I.6.5.

[4]Some sources quote as day of his death the 8th of January. However, BOP, ms 758 is very clear on this point, adducing the information that it coincided with Epiphany and a Saturday. Both these facts match with January 6th 1607, cf. A. Cappelli, *Cronologia Cronografia e Calendario Perpetuo*, cit.

[5]For the sad reactions to Guidobaldo's death, cf. Appendix I, I.7.1. Note especially the letter from Alessandro dal Monte to Galileo which is another clue for the close relation between the dal Monte and the Tuscan mathematician.

[6]Cf. BOP, ms 966, "*Cronica di Pesaro*" of D. Bonamini, p. 180.

I.3 Aftermath

Novello Euclide, o Guidobaldo industre
theorico d'ogni arte
che a' numeri, a' misure, a leva e a pondo
fatt'hai più chiaro il mondo
et più il tuo monte vago, eccelso e illustre.
Seben lice or' di saper gli trionfi i tuoi
dimmi del cielo in qual più degna parte
con teco stanno i più famosi eroi?

L. Agostini in occasion of Guidobaldo's death in *Rime*, BOP, ms 193bis, fol. 185r.

The fall of the dal Monte house

Now Francesco Maria (II) became Count of Monte Baroccio, as Guidobaldo's first born son. A year later, Francesco Maria II della Rovere made him even Marquis[1] of Monte Baroccio.[2] Guidobaldo's son had turned to represent his family at court,[3] and was entrusted with diplomatic missions in the Duke's name, in particular with Philip III King of Spain, with the Grand Duke of Tuscany and the Duke of Mantua.[4] Possibly, he could have partly restored the damaged influence of his house, if he had not died already in the year 1619.

From his marriage with the Roman aristocrat Isabella Savelli, contracted only in 1609, he had got two children: Ranieri dal Monte (II), born in 1610, and Felice dal Monte (II), cf. figure I.5. As the enfeoffment of Monte Baroccio provided the inheritance of the county (in the meantime marquisate) only in the line of the first born son, and therefore excluded the consideration of Guidobaldo's other sons, the title of Marquis of Monte Baroccio passed down to Ranieri (II), who had only nine years at the death of his father.

[1] In the secondary literature, there is sometimes confusion about Guidobaldo's title, reported with "Marquis of Monte Baroccio": but, in reality, he was only a member of the (widespread) family "Marchesi del Monte (Santa Maria)", but not its head, and further *Count* of Monte Baroccio. Only his first born son Francesco Maria (II) becomes also *Marchese* of Monte Baroccio.

[2] This is a hint at the fact that not all members of the dal Monte family had fallen in the Duke's disgrace, despite of the deteriorated relations between Guidobaldo and Francesco Maria II. In effect, for example Carlo dal Monte continued to be in the latter's service (as soldier) during Guidobaldo's exilement, cf. BOP, ms 426.

[3] Cf. the payroll of the Duke's court in 1608 (ASF, Ducato di Urbino, III, 23): Francesco Maria dal Monte (II) compares as "Signor di Monte Baroccio", even if his position is far inferior compared to the ones of his father, grandfather and uncle in the 1580s, cf. I.2 and Appendix I, I.4.4.

[4] Cf. G. Allegretti, *Monte Baroccio 1513-1799*, Mombaroccio, Comune di Mombaroccio, 2002.

Unfortunately, Guidobaldo's grandchild turned out to possess a problematic character: highly significant in regard is a letter in which his mother desperately approached the Duke in order to ask help in the education of her son.[1] Also the Cardinal dal Monte seems to have been involved in the efforts to control the situation and to prevent any greater damage from the family,[2] but in the end things went out of control: Ranieri (II) dissipated the fortune of the family, piled up debts, picked a fight in which Count Giulio Cesare Mamiani lost his life and was finally incarcerated in the dungeons of the Inquisition (1636).[3] He would not have ever turned to Monte Baroccio, and eventually died in 1644.
His unique son Guidobaldo (II), born in the meantime in 1642, was deceased only one year after his birth. So, the line of the first born male descendants of Ranieri dal Monte was interrupted and consequently, after almost exactly one century, the seigniory of the dal Monte house at Monte Baroccio had come to an end.

The posthumous publication of unedited writings of Guidobaldo

Soon after Guidobaldo's death there were made the first attempts to publish the part of his treatises which had remained unedited. Among the involved persons were Orazio, Uguccione and Giovanni dal Monte – their father had nominated, in his last will of 1607, the three sons as heirs of the scientific part of his patrimony.[4] Further also some of Guidobaldo's old friends and scientific interlocutors were involved in the publication works, namely Pier Matteo Giordani, Bernardino Baldi or Cesare Benedetti.
In spring 1608, the group had approached the Cardinal dal Monte, in search of founds for the planned publications, after having chosen the *Problematum astronomicorum Libri septem* as first writing to release. The Cardinal, however, was not able or willing to finance the project.[5] Consequently, Guidobaldo's heirs seem to have been constrained to chose cheap and apparently not very competent editors.[6]

[1] Cf. Appendix I, I.7.2.

[2] Cf., again, Appendix I, I.7.2.

[3] Note that the Mamiani were probably the most influential family of the court at the beginning of the seventeenth century. For a more detailed account of these happenings, cf. G. Allegretti, *Monte Baroccio 1513-1799*, cit.

[4] The respective passage reads: "Agli Illustrissimi Signori Oratio, Uguccione et Giovanni lasciò per prelegato tutti i suoi libri di mattematica, cassettini, stucci, compassi, ferri, bossole, modelli, instrumenti et disegni stampati e non stampati con ogni altra cosa pertinente alla professione mattematica." Cf. ASP, fondo Notarile, Vasconi Giovanni, busta 1732/1746, fols. 1v-5r; see Appendix I, I.6.5.

[5] It is a letter from O. Tortora to Pier Matteo Giordani (BOP, ms 415, fol. 62r/v; May 21st 1608) that documents this fact; see Appendix I, I.7.3.

[6] The editors of the *Problematum astronomicorum Libri septem* were Gio. Batt. Ciotto and Bernardino Iunta. For Orazio's complaints about them, cf. below.

Several conserved letters reveal interesting insights in the proceedings of the publication works: It is particularly Orazio, the eldest of the three heirs, who has to be considered as the *spiritus rector* of the whole enterprise. Staying in the meantime at Crema as *Governatore* in the service of the Venetian Republic, he not only controlled the works in regard of their mathematical content, but also organised, from distance, the collaboration between the editors at Venice and his collaborators at Pesaro. There, it was mainly thanks to Pier Matteo Giordani, regarded as the authority concerning Guidobaldo's scientific heritage, that the works went on: several times, Orazio asked his advice and more then once he stated that Giordani's mere authorship of comments or figures was sufficient to guarantee their quality, given his "close acquaintance <with Guidobaldo's work> and most erudite talents".[1] So it was he who has chosen, for example, the figure and the motto of the frontispiece of the *Problematum astronomicorum Libri septem*. Besides P.M. Giordani, also Bernardino Baldi had a central role in the enterprise, by controlling the mathematical problems of Guidobaldo's manuscripts.[2] Minor responsibilities were assumed by Uguccione, Giovanni and Alessandro dal Monte as well as by Cesare Benedetti.[3]
Interesting is the exclusion of Muzio Oddi from the publication endeavour: the reason of this fact probably were divergences between Guidobaldo's disciple and Orazio or his brothers.[4] Generally, the former was much more sceptical about the publication of Guidobaldo's manuscripts, evidently in difference to the involved characters, assuming the opinion that Guidobaldo's "other published things were substantial and treated important subjects and had a higher relevance" than the unedited manuscripts. His proposal, instead, was to add new elements to the existing writings and to make them, thus, more interesting.[5] In effect, Oddi in-

[1]For example, cf. Orazio's letter to P.M. Giordani of October 29th 1608 (BOP, ms 412, fols. 41r-42v): "A me basta che venghi da Lei che per la domestica intrinsichezza e per le dottissime qualità con che trattava con mio Padre [le figure] come così fatte da esso Signore." See Appendix I, I.7.3. This fact emphasises once more P.M. Giordani's familiarity with Guidobaldo's work.

[2]For example, cf. Orazio's letter to P.M. Giordani of June 16th 1610 (BOP, ms 412 fol. 52r/v): "Poiché Monsig. Abb. Baldi vedrà gl'opuscoli et il parere di esso Signore ne darà la vera scorta, il quale con quello di V.S. farranno che l'opere di mio Padre comparischino come devono." See Appendix I, I.7.3.

[3]Cf. BOP, ms 412, fols. 41r-42v: "Non dubito che ciò che venirà dalla mano di V.S. sarà cosa per mettere in testa de' *Problemi Astronomici* senza che Lei mi voglia addurre testimonii che il schizzo fatto sin'ora secondo il Suo volere sia piaciuto a Monsignor <Cesare Benedetti> Rev.mo Vescovo et al S.r Alessandro mio fratello (..)." See Appendix I, I.7.3.

[4]In effect, in the letter to Pier Matteo Giordani of August 8th 1612 (BOP, ms 413, fols. 9r-10r), Oddi complains: "Di me questi SS.ri <figli di Guidobaldo>, o per dir meglio una parte di loro, non hanno oppennione alcuna buona" – and this, as he continues immediately, is the reason why he is not willing to assist them in any way: "e perciò mi conosco in tutto innabile a adarli né aiuto né consiglio, solo li compatisco col'affetto."

[5]Cf. BOP, ms 413, fols. 7r-8v (not dated, but prior to August 1612): "M'ha cavato V.S. con la Sua lettera un bel fastidio del capio per il dubbio che aveo che quei Sig.ri del Monte, consigliasi solamente coll'oppessione del proffondo sapere del Sig.r Guidobaldo di felice memoria

tended to publish two works of Guidobaldo on his own, with additions.[1] It is plausible that also this intent contributed to the mistrust of the latter's heirs towards him.

The publication result of the *Problematum astronomicorum Libri septem*, released in spring-summer 1609, apparently was not satisfying: Orazio complained both to Pier Matteo Giordani and to Galileo about the Venetian editors.[2]
Despite of the bad experiences, the group approached the issue of the other, remaining manuscripts: their efforts concentrated on a treatise on a special type of sundials, *Orologi a raggi refratti nell'acqua*,[3] on Guidobaldo's commentary on the fifth book of Euclid's Elements,[4] and, above all, on the *Cochlea*. Orazio was understandably concerned about the question where to publish them and approached also Galileo in this context.[5] At the same time, i.e. in summer 1610,

e col desiderio della gloria paterna, non presistessero in voler publicare i suoi opusculi; perché invero, sebene ci sono delle cose belle e buone, che forse il mondo l'aggradirebbe, non credo però che publicarle *ex professo* se li aggiongesse né onore né credito, essendo l'altre cose publicate da lui grave e di sogetti importanti, e di meglior peso di questi. Non dirò già che alcune cose si dovessero lasciar sepolte, ma le porei publicar con qualche inventione." Another negative judgement on the publication of Guidobaldo's heritage is contained in Oddi's letter to Pier Matteo Giordani of August 8th 1612 (BOP, ms 413, fols. 9r-10r): "Non posso già negare che non mi rincresca molto il sentire certe cose sì fatte di questi SS.r d'intorno alle fatiche del lor Padre; che se non fosse V.S. che pure con la Sua autorità li tiene un poco a freno, Dio sa come starieno le cose." The complete transcriptions of both letter are exposed in Appendix I, I.7.3.

[1]The question is about his treatise on a sundial which worked with refracted rays and about a paraphrase on a passage of Hygenius on the meridians. Oddi, in a letter to Pier Matteo Giordani (BOP, ms 413 fols. 7r-8v; not dated, but prior to August 1612), claims, in regard, to have received Guidobaldo's authorisation to publish the latter's invention of the sundial with refracted rays: "Del publicar col mio libro, questo opuscolo <di Guidobaldo sull'orologio a raggi rifratti> n'ebbi pensiero sino da [Loreto] e ne scrissi al Sig.r Guidobaldo e fra le mie scritture vi sarà la risposta dove mi dava licenza." Yet, as its letter of August 8th 1612 (BOP, ms 413, fols. 9r-10r) reveals, he was not able to document this authorisation and, meeting the resistance of Guidobaldo's heirs, he refrained from this plan: "Mio fratello un pezzo fa mi scrisse, che per molta diligenza usata in cercar la lettera che il S.r Guidobaldo di felice memoria mi scrisse in Loreto intorno allo stampare il suo opusculo *Degl'Oroglogio coi raggi rinfranti nel l'aqua* non l'avea potuta trovare; né io volendo cosa fuori del gusto di quei SS.ri suoi figli, aveo in tutto dismesso il pensiero che mi avea preso d'esso, non sapendomi imaginare qual cagione li potesse aver mossi a questa resistenza, e qual pregiuditio stimino che possa recare alla fama di quel Sig.re il stampare e ristampare in diverse lingue l'opre sue." For the complete transcription of the letters in question cf. Appendix I, I.7.3.

[2]Cf. Orazio's letters to Pier Matteo Giordani of July 25th and August 26th 1609 (BOP, ms 412, fols. 47r/v and 49r/v), and to Galileo of June 16th 1610 (BNCF, ms Gal. 88, fol. 136r); see Appendix I, I.7.3.

[3]Cf. BOP, ms 413, fol. 15r/v. This treatise seems to be lost.

[4]The work is called *In quintum Euclidis Elementorum Librum Commentarius Opusculum* and conserved at the Biblioteca Oliveriana Pesaro, as ms 630.

[5]Cf. his letter of June 16th 1610 (BNCF, ms Gal. 88, fol. 136r), published in G. Galilei, *Opere*, vol. X. It is very interesting, as it contains a list of the manuscripts to be published; see Appendix I, I.7.3.

the correction works seem to have been already begun.[1] Yet, for the successive four years, the extant documentation does not reveal any decisive progresses. Only at the beginning of 1614, Orazio dal Monte concretised the efforts to publish the *Cochlea*: he seems to have concluded a contract with the editor.
Yet, in August of that year, Orazio, who had been in the meantime appointed *Governatore dell'Armi del Regno di Candia* in Crete,[2] deceased – evidently a grievous blow for the publication enterprise. Fortune in misfortune, the works on the *Cochlea* were in an advanced state, so that the work could appear only one year afterwards, together with the re-editions of the *Mechanicorum Liber* and *Le Mecaniche*.[3] The plan of releasing also the *opuscula*, however, were abandoned, probably for the lack of the driving force of Orazio. With them, also Baldi's *Vita di Guidobaldo* remained unpublished – and seems lost, now – which was, according to I. Affò, destined to introduce their edition.[4]

[1]Cf. Orazio's letter to Pier Matteo Giordani, again of June 16th 1610 (BOP, ms 412 fol. 52r/v): "Poiché Monsig. Abb. Baldi vedrà gl'opuscoli et il parere di esso S.re ne darà la vera scorta, il quale con quello di V.S. farranno che l'opere di mio Padre comparischino come devono." See Appendix I, I.7.3.

[2]Cf. BOP, ms 1063, tomo I, fol. 296r.

[3]Cf. P. Riccardi, *Biblioteca matematica Italiana. Dalla origine della stampa ai primi anni del secolo XIX*, Milano, Görlich, 1952.

[4]In fact, the status of the unedited manuscripts is unclear. There are hints that not everything has got lost. We are momentarily conducting researches in this regard intending to publish, in the near future, information that could be useful for the search of the remainders of Guidobaldo's scientific patrimony.

Chapter II

General hints at Guidobaldo's intellectual *milieu*

It is known who were the "great" scholars with whom Guidobaldo maintained scientific contacts, exponents of sixteenth century mathematics like Commandino, Clavius, Galileo, Barozzi, Magini etc. It is similarly evident to whose works he referred to in his own writings, namely authorities like Archimedes, Aristotle, Pappus and (in his eyes) opponents like Jordanus, Tartaglia, Cardano, Benedetti. In contrast, it is more difficult to answer the question who his every-day interlocutors were (or if he had any), with whom he could discuss about the topics he was working on, and by whom he, possibly, got stimuli for his studies.
The present chapter intends to delineate an overview on the general characteristics of the cultural-scientific climate in the Duchy of Urbino in which Guidobaldo's work has to be contextualised and, thereby, to lay the ground for the possibility to approach the problem of a better understanding of his environment. Against the background of his biography (cf. chapter I), two milieus *of the Duchy seem to have been particularly decisive for his formation and scientific activity: the court on the one side, and the world of the technicians and engineers on the other;*[1] *they are dealt with in the sections II.1 and II.2. The third and last section II.3 of the present chapter exposes documents, testifying that a circle of scholars both with philosophical-mathematical and technical-practical interests had gathered around Guidobaldo. Then, the subsections IV.1.2 and V.1.2 dwell in a more detailed way on Guidobaldo's technical collaborators and scientific interlocutors.*

[1] Important and interesting information about the scientific dimension of the Duchy of Urbino is exposed in P.L. Rose, *The Italian Renaissance of Mathematics*, cit., and in E. Gamba, V. Montebelli, *Le Scienze a Urbino nel tardo Rinascimento*, cit. The present chapter concentrates to Guidobaldo's environment, and intends to enlarge upon the analysis of this part of Rose's and Gamba&Montebelli's study.

II.1 The courtly environment

As far as the courtly ambiance is concerned, essentially two characteristics are reported by the extant sources that turn out to be relevant for our purposes: a great attention towards philosophy, in particular to Aristotle's work. And, on the other hand, a profound interest towards mathematics in a larger sense, including mechanics and fortification.

The interest in mathematics, mechanics and fortification

The Dukes of Urbino traditionally were military captains, in changing services of the Venetian Republic, the Pontifical State and the Spanish King.[1] One of the tasks connected with this appointment was fortifying their seigneurs' lands – a task important also for their homelands. Famous is the role assumed by Duke Francesco Maria della Rovere (1490-1538) in the fortification of the Venetian territory.[2]
The planing of fortifications, but also the organisation of military campaigns obviously required an occupation with technics and mechanics: the movement of heavy loads (e.g. cannons), the construction of stable walls etc. evidently are mechanical problems. Further, in the course of the sixteenth century, mechanics had lost its "image" as occupation exclusively for the lower social class.[3]
Even if the political landscape was changed in the second half of sixteenth-century Italy in comparison to the precedent century, and consequently also the role of the Duchy in it, these historical roots still were sensible in the Urbinate ambiance: so the Venetian ambassador Federico Badoer, in 1547, comments on the counts and intimates of Duke Guidobaldo II that "all of them live on warfare".[4]

This is the context in which Prince Francesco Maria and Guidobaldo dal Monte grew up. Both of them prepared themselves to become military men; whence, also the study of mechanics (and, more generally, of mathematics) was necessary. In effect, several Venetian ambassadors testify this form of the Prince's education. Badoer writes:

[1] Cf. Part A, I.1 and J. Dennistoun, *The Dukes of Urbino*, cit.

[2] Cf. E. Concina, *La macchina territoriale*, cit.

[3] An important factor in this process was played by the discovery of the Aristotelian *Quaestiones Mechanicae*, which argues that mechanics is a science. Further, the interest of Aristotle himself for the topic (leaving apart the question if the text really is written by the Philosopher or by one of his disciples) contributed to a higher reputation of the discipline. For example, the *Quaestiones Mechanicae* were discussed by cardinals during the Council of Trent, cf. P.L. Rose, S. Drake, *The Pseudo-Aristotelian* Questions in Mechanics *in Renaissance Culture*, "Studies in the Renaissance", XVIII (1971), pp. 65-104.

[4] Passages of this and the other Venetian diplomatic reports are transcribed in Appendix II, I.1.

> [Prince Francesco Maria II] thoroughly dedicates himself to physical exercises, as playing with the ball, chasing, walking and other similar exercises, in order to accustom himself to the inconveniences of war, as His Excellence plans that he, too, undertakes the profession of arms (...). He studies, is intelligent in mathematics and fortifications, and anyway, he enjoys all those things that belong to a prince.[1]

Also ambassador Matteo Zane, some years later (1575), confirms Badoer's report:

> [Duke Francesco Maria II] is studious and really well-read, and dedicates himself particularly to the weapons and to be a soldier.[2]

So, this "intelligent" young Prince took pleasure in "mathematics and fortifications": to such an extent that he made Commandino teach him mathematics. Baldi writes in his *Commandino's Vita* in regard:

> (...) So [Commandino] wanted to terminate many works that he had already begun, when Francesco Maria, son of our Duke Guidobaldo <II>, young man of heroic mind, knowing how well those sciences fit to someone who is about to govern and to dedicate himself to warfare, did not permit to Federico to stay closed between the walls of his father's house. He offered him very honourable conditions, and wanted to call him in his service, as already his father had done. Commandino, entered in his employ, read to the Prince Euclid's *Elements* and received much satisfaction by interpreting them.[3]

This account is confirmed by Francesco Maria II's autobiography.[4] Around the Prince, the members of his court like Guidobaldo, probably his brother Francesco

[1] Cf. "Badoer's relation of 1547" in Appendix II, I.1: "[Il Principe Francesco Maria II] si dà molto alli essercizi del corpo, come al giocar della palla, all'andar a caccia, a piedi ed altri simili essercizi, per abituarsi alli incommodi della guerra, disegnando Sua Eccellenza di seguir anch'egli il mestier dell'armi (...). Studia, è intelligente delle matematiche e delle fortificazioni, e insomma si diletta di tutte quelle cose che veramente sono appartenenti ad un principe."

[2] Cf. "Zane's relation in 1575" in Appendix II, I.1: "<Duca Francesco Maria II> è studioso e litterato assai, e fa profession soprattutto d'arme e d'esser soldato."

[3] Cf. E. Nenci (ed.), *Bernardino Baldi, Le vite de' matematici. Edizione annotata e commentata della parte medievale e rinascimentale*, Milano, Angelo, 1998: " (...) Attendeva [Commandino] egli adunque a condurre a fine molte opere già da lui cominciate, quando Francesco Maria, figliuolo di Guidubaldo nostro Duca, giovane d'animo eroico, sapendo quanto quelle scienze stiano bene a chi è per sostenere il carico del governo ed è per dar opera all'arti militari, non comportò che Federico se ne stesso rinchiuso fra le mura della casa paterna, ma propostogli onoratissimi partiti, // volle, come aveva già fatto il Padre, chiamarlo ai suoi servizi. Nello quale entrato leggendo a quel Principe gli *Elementi* d'Euclide apportava lui molta sodisfazione nell'interpretarli."

[4] Cf. BOP, ms 386, fol. 223r/v (written in the the third person): "After a few months, seeing that his father made no movement in the affair of his marriage, he returned to his studies, interrupted during his absence from Italy; first concerning mathematics, read to him by Federigo Commandino, and afterwards concerning philosophy by Cesare Benedetti, Giacomo Mazzoni and Cristofero Guarimone."

Maria dal Monte, Giulio Giordani and others, like Torquato Tasso, frequented these lessons as well.
The enthusiasm with which the young Prince approached these lessons is impressively testified by another document stemming from 1575, few months after the ascension to the throne by the new Duke Francesco Maria II. The nobleman Almerigo Almerici wrote to his son Virginio

> The Duke is well but always very busy with affairs and public audiences that take place every day indifferently. And until now he succeeds in being a great prince and says that his only discontent is not to be able to continue his studies.[1]

The interest in philosophy at court[2]

However, occupation with warfare and interest in certain mathematical disciplines were not the only traits that characterised the courtly environment: above all, the Duchy of Urbino was an important cultural centre in the fifteenth and sixteenth century. In effect, famous artists, architects and men of letters like Raffaelo Sanzi, Piero della Francesca, Luca Pacioli, Francesco di Giorgio Martini, Aretino, Torquato Tasso were connected with its court over several decades. In this regard, ambassador Badoer stresses:

> The court of the Duke and of all this house, as by custom, has always been honourable: in fact, at all times it has hosted the most eminent men of Italy, both for warfare as well as for letters.[3]

This cultural interest concerned not least also philosophy. An extant description of Carnival 1574 is particularly interesting in this regard, as it permits us to get an idea of the general intellectual climate at the court, and especially of its members' interest in philosophy (note the presence of Duke and Prince during the discussions):

> We have enjoyed many other discussions between remarkable minds like <Jacopo> Mazzoni of Cesena, <Torquato> Tasso, Pino of Cagli and master Cesare Benedetti. (...)

[1] Cf. BOP, ms 1577, letter number 35 (January 10th 1575): "Il S.r Duca sta bene ma occupatissimo sempre ne' negotii et nelle audienze publiche che sonno ogni giorno indeffessamente. Et sin qui fa reuscita di gran prencipe et dice che il maggior scontento che abbia il non poter continuare li suoi studii."

[2] Another discipline that seems to have been important in the courtly *milieu* was astronomy. A scholar that dedicated large parts of his work to this field was Federico Bonaventura. Also Guidobaldo attended to astronomy. Yet, here is not the place to go into detail in regard.

[3] Cf. *Relazione di Federico Badoer*, see Appendix II, I.1: "La corte del Duca e di tutta quella casa, come per una consuetudine, è stata sempre onorevole, percioch''e in ogni tempo, e nell'armi e nelle lettere, ella ha avuto de' più segnalati uomini d'Italia."

> First, I heard that a discussion began in front of the Prince, when Mazzoni has arrived, and it was about Mazzoni and master Cesare about the difference that is between Plato and Aristotle regarding reminiscence; Mazzoni tried to defend the opinion of Plato and his followers, and master Cesare took up Aristotle's.
> Another time, during the party and the dances, Tasso and Mazzone had a disputation and I was present. One part of the discussion was that Tasso held that Epicure considered the carnal pleasures as the greatest good and that he was evil; Mazzoni seemed to have argued that he had always had a high opinion about moral and that, therefore, he was not as described by Cicero and Plutarch (...); they reasoned on this a while, and I really recognised that this Mazzoni is much well-read and has a most tenacious memory and of a more than average culture, and that Tasso is a very sagacious and perspicacious thinker.[1]

Correspondingly, Torquato Tasso who had lived a certain time at the Urbinate court, calls Duke Francesco Maria II della Rovere "Prince educated as a philosopher".[2] Francesco Maria II confirms this statement in his autobiography (writing about himself in the third person singular):

> He turned to his studies (..), first concerning mathematics, read to him by Federigo Commandino, and afterwards concerning philosophy by Cesare Benedetti, Giacomo Mazzoni, and Cristofero Guarimone.[3]

[1] Cf. BOP, ms 390, fols. 92r-97v: "Abbiamo goduto ancora molti ragionamenti (...) passati fra molti begli intelletti come dire il Mazzone da Cesena, (...) il Tasso, il Pino da Cagli e ms. Cesare Benedetti (..).
Intesi primieramente che presò ragionamento innanzi il Principe alla venuta del Mazzone (...) e fu fra il Mazzone e ms. Cesare sopra la differenza ch'è fra Platone et Aristotile intorno alla Reminicenza, dove il Mazzone cercò di diffendere l'opinione di Platone e de' seguaci e ms. Cesare **vi** sosteneva quella d'Aristotile.
(...) Un'altra volta s'attaccarono in festa mentre si ballava il Tasso et il Mazzone, et io mi trovai presente. Fra gli altri a una parte della contesa ch'era allora cioè che il Tasso teneva ch'Epicuro ponesse tutto il sommo bene ne' piaceri del corpo e che fosse cattivo, et il Mazzone pareva che tenesse ch'egli avesse avuto sempre buona opinione nelle cose morali e che però egli non fosse tale quale si trova descritto da Cicerone e da Plutarco (...), sopracché contesero un pezzo dov'io conobbi veramente che quel Mazzone era d'una gran lettione e di grandissima memoria e dottrina più che mediocre, et il Tasso avvertito molto et accorto ragionatore."

[2] Cf. the letter written by Tasso to Francesco Maria II in 1578: "E s'avessi così // a parlar con Vostra Altezza come ho a scrivere, non senza molto rossore potrei ragionare: ma la scrittura non arrossa; e con Vostra Altezza posso laudar me stesso, senza noiar Lei in alcuna parte: percioché Ella è così ricca de l'eccellenze e de le laudi convenevoli a principe, ed a principe formato di filosofo, che udendo le laudi de' privati, non ha che invidiare o di che rammaricarsi." See C. Guasti, *Le Lettere di Torquato Tasso*, Firenze, Le Monnier, 1852, vol. I, pp. 279/80.

[3] Cf. BOP, ms 386, fol. 221v: "ritornò alli suoi studii tralasciati mentre era stato fuori d'Italia, li quali furono prima di matematica lettagli da Federico Comandino, poi di filosofia

The importance attributed to (Aristotelian) philosophy by Francesco Maria II must have been considerable, as we can deduce from his diary:

> On the 25th <January 1585>: I finished to see all works of Aristotle. I have struggled with them not less than 15 years, having been read to me mainly by Cesare Benedetti.[1]

In comparison, his studies on the Bible were lasting less than four years.[2] This is even more significant if one considers that Francesco Maria II was deeply religious.[3]
Generally, the profound interest of Francesco Maria II as Duke must have had extensive consequences also for the courtly *milieu*: in effect, the leading philosophers of the Duchy, Federico Bonaventura and Cesare Benedetti, were proponents of the Aristotelian philosophy.

Convergences between the cultural *milieu* of the court and interests of Guidobaldo and his interlocutors

The information about Prince/Duke[4] Francesco Maria II's interests in mathematics/mechanics and philosophy might seem, at first sight, hardly relevant for a better understanding of Guidobaldo's scientific environment. Yet, it is advisable to keep in mind that Guidobaldo grew up at the Prince's side from early childhood, was one of his closest intimates and, until the age of 18, enjoyed the same formation as the Prince. So it does not astonish that the mixture of interests in mathematics and philosophy is reflected also in his scientific work.[5] And not only in Guidobaldo's, but also in the works of his disciples and/or interlocutors – contemporaneously members of the court – Count of Carpegna, Jacopo Mazzoni, Bernardino Baldi, Omero Tortora, Curzio Ardizi, Pier Matteo Giordani and so on:[6]

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da Cesare Benedetti, Giacomo Mazzone e Cristofero Guarimone (...)." Interestingly, the Duke cancelled the name "Felice Paciotto" before "Cesare Benedetti". The reasons for this seem to be still unclear.

[1] Cf. F. Sangiorgi, *Diario di Francesco Maria II della Rovere*, Urbino, Quattroventi, 1989: "A' 25 <gennaio 1585>: detti fine di vedere tutte l'opere d'Aristotele, nelle quali mi ci sono affaticato non meno di 15 anni, essendomi state lette da messer Cesare Benedetti da Pesaro per la maggior parte."

[2] Cf. F. Sangiorgi, *Diario di Francesco Maria II della Rovere*, cit.: "18 <agosto 1587>: Finii di vedere tutta la Bibbia con diversi argomenti, nel quale studio vi posi il tempo di tre anni e dieci mesi."

[3] Not only the Venetian ambassador Zane tells: "Fa profession di Principe giusto ed è religioso molto. Procura Sua Eccellenza che li sudditi suoi vivano col medesimo zelo di religione, e lo Stado era visitado al presente, per ordine del Pontefice, dal vescovo Ragazzoni, con molta sodifazione di Sua Eccellenza e grandissima laude di quel prelato."

[4] Francesco Maria II became Duke in 1574.

[5] For further information on this topic, cf. Part A, chapter V, particularly V.1 and V.2.4.

[6] For information on the biographies and, potentially, their works, cf. Appendix II, II.1.

Tommaso Count of Carpegna, frequently active in diplomatic missions on behalf of the Duke, was interested in philosophy and encouraged by his brother-in-law Federico Bonaventura, on his part Aristotelian philosopher, to study Aristotle's philosophical works. But he was similarly interested in mechanics: even if the creation process of Baldi's *Exercitationes* is not entirely cleared,[1] we know by the funeral oration in his honour, that it was the Count of Carpegna who asked Baldi to write the commentary on the *Quaestiones Mechanicae*.

Jacopo Mazzoni,[2] famous philosopher of his time and interlocutor also of Galileo, who had dwelt large parts of 1574/75 at the court, must have been notably influenced by the climate and interests of the Urbinate court, as his work *De triplici Hominum Vita* reveals: he thanks, in the preface, Francesco Maria II della Rovere and the dal Monte family for their support. As manifestation of these stimuli can be interpret the presence of a lengthy, 40-pages-passage on fortification and warfare, despite of the philosophical character of the work, that was finished and printed in 1576.

Curzio Ardizi, a man of letters and close friend of Torquato Tasso, must have enjoyed a formation also in mechanics and/or fortification: a recently discovered document reveals that he was sent by Duke Guidobaldo II to Tunis in order to draw up a map of the fortifications of that place and to send information about the surroundings.[3]

Omero Tortora, a historian and the author of the *Historia di Francia*,[4] appears to have been similarly influenced by this Urbinate environment with its orientation to warfare and mechanics: in his historical treatise, he reflects also about the destruction power of cannonballs, depending on the materials of which they are made. Interestingly, Tortora's reasoning in regard becomes a topic also in the controversy between Grassi/Sarsi e Galileo.[5]

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[1] Cf. B. Baldi, *In Mechanica Aristotelis Problemata Exercitationes*, edited by E. Nenci, Milano, Angeli, 2010; see particularly its introduction.

[2] For further information on Mazzoni and his work, cf. A. de Pace, *Le matematiche e il mondo. Ricerche su un dibattito in Italia nella seconda metà del Cinquecento*, Angeli, Milano, 1993.

[3] For further information on Curzio Ardizi and his trip to Tunis, cf. Appendix II, II.2.

[4] Cf. O. Tortora, *Historia di Francia*, Venezia, Ciotti, 1619.

[5] It may not be excluded that Galileo had become aware of this text by Guidobaldo himself, who might have spoken to him about his disciple Tortora's works on that book. For the controversy, cf. G. Galileo, *Il Saggiatore*, F. Flora (editor), Torino, Einaudi, 1977, pp. 214-216: Sarsi had written: "Anzi io so che talvolta le palle di piomo lanciate da grandi bombarde si liquefanno nell'aria. Omero Tortora, come modernissimo così diligentissimo scrittore delle cose galliche, dice che talvolta fu inutile la gran forza delle palle lanciate dalle macchine belliche a distruggere le mura perchè, essendo prima piccole e di ferro, erano state poi ingrandite con piombo fatto cadere sopere loro: «esplodendo infatti, dice, contro le mura, poiché il piombo si liquefaceva nell'aria, solo il piccolo globo interno di ferro, grande quanto un nocciolo, perso l'involucro, arrivava al muro.»" Galileo replied in *Il Saggiatore*: "e come per autorizar gli antichi arcieri e frombolatori ha trovato uomini per altro insigni, così, per render credibile il medesimo effetto di liquefarsi le moderne palle d'archibuso e d'artiglieria, ha ritrovato un moderno istorico

So, despite of the completely different professions pursued by these interlocutors of Guidobaldo, there is one convergence: the interest in mechanics/fortification, often coupled with an occupation with philosophy or letters: the poet Ardizi that designs maps of a fortification in Tunisia, the historian Tortora that reflects upon the material properties of cannonballs, the philosopher Mazzoni that dwells upon fortification, the diplomat and *amateur* (in the good sense of the word) of philosophy Count of Carpegna that is interested also in mechanics: precious impressions of the cultural climate in the Duchy of Urbino.

And most probably, they were influenced also, and particularly, by their master and/or interlocutor Guidobaldo: in fact, the analysis of his work reveals influences of his occupation with philosophy and a kind of (attempted?) synthesis between mathematics and philosophy, as chapter V of Part A will evidence.[1] For example, in the fourth proposition of the *Mechanicorum Liber*, the Marchigian scholar exposes and demonstrates his theory of the isostatic balance and then goes on to confute in a lengthy digression the approaches to the topic brought forward by Jordanus, Tartaglia and Cardano.[2] Years later,[3] he explained that in this procedure of confuting his adversaries' arguments he had been inspired by Aristotle's model:

> And as this new opinion of his <i.e. Guidobaldo's indifferent equilibrium>, wholly proven in the aforesaid fourth proposition, should become completely clear, <Guidobaldo> did not content himself with having it proved with solid and well-founded argumentations; *but as a true philosopher, proceeding on the way of the royal discipline and of*

non men degni di fede né di minore autorità di qualunque altro antico. Ma perché non punto deroga di fede né di dignità all'istorico l'arrecare d'un effetto naturale vero una ragione non vera, essendo che all'istorico appartiene il solo effetto, ma la ragione è officio del filosofo; però credendo io al Signor Omero Tortora che le palle d'artiglieria, per essere state incamiciate di piombo, facesser poco effetto nel batter la muraglia nemica, piglierò ardire di negargli la ragione ch'egli, ricevendola dalla commune filosofia, n'adduce; (...) Credo dunque al Signor Tortora, che le palle di ferro covertate di piombo nella batteria di Corbel facesser poco effetto, e che di loro si ritrovasser l'anime di ferro spogliate di piombo; e questo è tutto quello ch'appartiene all'istorico: ma non credo già l'altra parte filosofica, cioè che il piombo si liquefacesse, e che perciò si trovasser nde le palle di ferro; ma credo che giungendo con quello estremo impeto che dal cannone veniva cacciata la palla sopra la muraglia, la coverta di piombo in quella parte che rimaneva compressa tra'l muro esterno e l'interior palla di ferro si ammaccasse e sbranasse, e che l'istesso o poco meno facesse anco l'altra parte del piombo opposta, schiacciandosi sopra il ferro, e che tutto il piombo, dilaniato e trasfigurato, saltasse in diverse bande, il quale poi, imbrattato da calcinacci e perciò simile ad altri fragmenti della ruina, malagevolmente si ritrovasse, e forse anco per avventura non fusse con quella diligenza ricercato, ce richiederebbe la curiosità di chi volesse venire in cognizione s'ei si fusse strutto o pur dilacerato;"

[1] Cf. in particular section V.1 and subsection V.2.4.

[2] An in-depth analysis of this topic is exposed in Part B, chapter I.

[3] In the vulgar translation of his major work on mechanics, *Le Mechaniche*, Guidobaldo made Pigafetta add a scholium in which he explained the reasons for this procedure.

> *sound science* (imitating Aristotle who, at the beginnings of his book, investigating better theories, has contradicted the ancients, disproving the argumentations adopted by them), *<Guidobaldo> wanted to expose the approaches of his predecessors (as there is only one truth), and examine their reasons*, which seem to prove the very contrary; and he intended to contradict them, evidencing their falsity with the present digression.[1]

So, Guidobaldo oriented himself towards the Aristotelian model of arguing and applied it to mechanics. But this is not the only "philosophical" influence on his work: he reflected also on light bodies and approached the problem of embedding Archimedes's mechanics into the conception of the Aristotelian cosmos.[2] Further, as again chapter V will evidence, a circle of scholars with philosophical interests had formed around Guidobaldo in the course of the years.

II.2 The world of the technicians in the Duchy of Urbino

Considering Guidobaldo's environment, one cannot ignore the engineers' and technician's world in the Duchy of Urbino. Several documents testify that the Marchigian mathematician was strongly connected with this *milieu*. Its (even partly) reconstruction is more difficult compared to the court's, since there are less extant sources about it. Yet, the present section tries to reach an overview of it, all the same:

A particularly important technical branch in the Duchy was the fabrication of precision instruments for which its offices were nationally, if not even internationally renowned.[3] The produced devices were particularly mechanical clocks – *inter alia* offered as gifts to Popes, Cardinals, Kings and Dukes – but also scientific instruments, like planispheres, high precision balances (like the isostatic balance) or proportional compasses. Not by chance, it was at Urbino that Galileo made construct a part of his military compasses.

[1] Cf. F. Pigafetta, *Le Mechaniche*, fols. 28v-29r: "Et affineché questa nova opinion sua, dimostrata a pieno nella predetta quarta propositione resti totalmente chiara, non si è già contentato egli d'averla dimostrata con vive ragioni et certe solamente, ma come buon filosofo, procedente con via di reale dottrina, et di fondata scienza, (imitanto Aristotele, il qual ne' principii de' suoi libri, investigando dottrina migliore, ha datto contra la opinione degli antichi, solvendo le ragioni addotte da loro) ha voluto, essendo la verità una sola, proporre le opinioni de' suoi predecessori et esaminare le loro ragioni, le quali sembrano provar il contrario et solverle, la loro fallenza dimostrando col presente discorso (...)." The emphases are ours. The entire passage and the draft sent to Pigafetta by Guidobaldo, are exposed in Part B, I.4.1.

[2] Cf. Part A, V.2.4.

[3] A more detailed study on this topic, executed together with prof. E. Gamba, is forthcoming, cf. footnote 4 on page 36.

Further, Urbino was an important centre of military architecture. In the course of few decades it had generated and/or hosted several eminent figures of this branch, as Francesco Maria della Rovere, Giorgio Martini, Gerolamo Genga, Giovanni Battista Belluzzi, Francesco Pacciotti etc. Often, these highly qualified engineers then were "head-hunted" by the neighbour states, like the Venetian Republic, the Duchies of Mantua and Piedmont or the (Grand)[1] Duchy of Tuscany.
As far as civil architecture is concerned, particularly the large-scale projects forwarded by the Dukes seem interesting. Among them, focusing only on Guidobaldo's lifetime, we know about hydraulic works in connection with the water supply of the park of the ducal Villa Miralfiore and with the new fountain in front of the Ducal Palace, further works at the port and the construction of the ducal Villa Vedetta.

As an analysis of the extant sources evidences, Guidobaldo was closely connected with all these branches: he supervised the clockmakers' work and had designed, in close collaboration with Simone Barocci[2] a planisphere and a proportional compass. Also his fabrication of isostatic balances surely is not unrelated to these circumstances.
Further, Guidobaldo, whose father Ranieri was an expert military engineer,[3] was in the service of, or did services to several princes relative to military architecture: by now, a relatively good cognition has been reached of his services to the Tuscan Grand Duke. Further, he has been engaged also by the Duke of Mantua, and one source suggests his services also to the Duke of Urbino.[4]
As far as his occupation with civil architecture is concerned, he was involved in all aforesaid ducal projects, with exception of the works at Villa Vedetta: he supervised the works on the water supply of the park of Villa Miralfiore, he was elected the responsible for the new fountain by the Council of Pesaro and moreover was the architect of the church S. Maria degli Angeli.[5]

Surely, the world of the technicians and engineers was rather autonomous in regard of the court as it was composed by members who obviously did not belong to the noble class of the Duchy, but were, in the best case, recipients of commissions by the noblemen. Yet, there were also contact points: the construction projects were supervised and commanded by members of the court (Guidobaldo, Girolamo Arduini, Count Giulio da Thiene, etc.) and also some of the interests that characterised the courtly ambiance, were shared by this culturally interme-

[1] Tuscany became Grand Duchy in 1569, by a bull of Pope Pius V.

[2] Simone Barocci was the head of a particularly important office of precision instruments; cf. Appendix II, II.2.

[3] Ranieri had written treatises on military architecture and was active, at Duke Guidobaldo II's side, in the restructuring of defence works of the Venetian Republic; cf. Appendix II, I.2.

[4] Cf. Part A, I.2 and IV.1.1.

[5] Again, cf. Part A, I.2 and IV.1.1.

diate stratum: obviously, it was interested in mechanics, and more generally, in mathematics.
In fact, as following sections will expose,[1] Guidobaldo (and other members of the court, like Count Giulio da Tiene) seems to have had the task to instruct the young generation of the engineers and architects of the Duchy: the offer of such a formation at the Duke's instance does not appear astonishing, since the availability of competent architects was obviously in the interest of the court. Yet, as they had not generally received a formation in Latin, they were not able to study the mathematical works many of which were written in Latin. The existence of (manuscript) vulgar translations of several mathematical works of Guidobaldo (and not only) in the Marchigian libraries and archives reflect the demand for vulgar translations.
Another contact point between the world of the engineers with the courtly one is a special kind of profession which there seems to have been in the Duchy: there is a conspicuous number of exponents of the noble class who were, at the one hand, active as military commanders. On the other hand, they operated also as civil and military engineers. Their connection with the court becomes clear by the diplomatic missions they fulfilled for the Duke of Urbino: exponents of these military-architectural-diplomatic profession were Ranieri and Montino dal Monte, Giulio da Thiene, Giovan Giacomo Leonardi, Aurelio Fregoso. Probably, also Guidobaldo would have pursued this kind of profession – considering his military experiences, his cognition of engineering and his closeness to the court – if he had not developed a serious form of sciatica which hindered him from continuing his military career.

II.3 Guidobaldo's scientific interlocutors and technical collaborators[2]

After this short overview on the general climate and ambiance in which Guidobaldo had grown up and worked, the present section exposes several documents that testify the existence of a circle of interlocutors and collaborators around him. Later, the sections V.1.2 and IV.1.2 of Part A, will dwell in a more detailed way on the characteristics and topics of these circles.

After the death of his father, Orazio dal Monte had attended to the posthumous edition of the *Problematum astronomicorum Libri septem*.[3] Sending some exemplars, which had just been printed at Venice, to Pesaro, he commented:

[1] Cf. Part A, IV.1.2 and VI.1.2.
[2] Biographical information on the characters cited in the present section is exposed in Appendix II, II.1.
[3] Cf. Part A, I.3

> I send 20 copies of <the *Problematum Astronomicorum Libri septem*> to Sir Giovanni <dal Monte> in order to distribute them there <at Pesaro>, and I have sent some to Rome. I had to be parsimonious because I have received only few exemplars; moreover, I would not have known to whom give them, since the talented friends of my father and mine who took pleasure in mathematics are dead.[1]

So, who were these "talented friends of <Guidobaldo> who took pleasure in mathematics" and lived at Pesaro? This is exactly the problem approached in the present subsection:
Some light on this question is shed by the following letter: in 1588, Guidobaldo apparently intended to invite some of his interlocutors at his feud Monte Baroccio, some 20 kilometres away from Pesaro, in order to "philosophise". Most of them, though, seem to have been reluctant on that occasion, so Guidobaldo wrote the following, rather polemical letter to his friend and main scientific interlocutor Pier Matteo Giordani:

> I would like to invite all philosophers to do me the honour to come to please me here <at Montebaroccio>.
> But master Tiberio <Almerici> would not take small pains to come next summer, if I invited him now, and I wonder if the violent heat has passed without which he cannot go around. I do not know if Father Pucci would come since the Fathers of S. Domenico are not here. I doubt that <Curzio> Ardizi is able to leave the quarrel in order not to let it down. Master Virginio Almerici cannot leave the agriculture.
> As far as Your person is concerned, if getting up late or some affair with Marino does not keep You busy, so I have some hope, particularly if Sir Camillo Mazza and You encourage each other; but You have promised it to me and so I really hope that you apply Yourselves. I kiss the hand of all of You.[2]

[1] Cf. BOP, ms 412, fol. 47r/v (letter to Pier Matte Giordani, 25th July 1609): "Ne mando 20 copie <dei *Problemi Astronomici*> al S.r Giovanni <dal Monte> da distribuirsi costà, et ne ho mandato a Roma et in questo [m'è] convenuto essere parco perché ne ho avuto pochi volumi, oltre che non avrei anco saputo a chi bene impiegarli, perché gl'amici virtuosi di mio Padre et i miei, che sentivano gusto delle Mattematiche sono [morti]."

[2] Cf. BOP, ms 426, fol. 159r/v (August 10th 1588): " Io vorrei invitar tutti i filosofi che mi favoriste di venir a favorirmi qua su <a Montebaroccio>. Ma messer Tiberio non farebbe poco se invitandolo adesso ci venisse quest'altra estate, che mi dubbito che siano passati li gran caldi senza li quali egli non pò andar atorno. Il Padre Pucci non so se ci venisse perché non ci sono li Frati di S. Domenico. L'Arditio non so se potesse lassar la lite, acciò non si desertasse. Messer Virginio Almerici non pò lassar l'agricoltura. Circa la persona vostra, se il levar tardi o qualche negotio del Marino non vi tiene occupato, io ci ho qualche speranza, massime se il Signor Camillo Mazza et voi vi farete animo l'un l'altro; ma mi avete promesso e però spero spero che attendarete. Io bascio le mani a tutti tutti."

The presence of scholars with scientific interests and the existence of discussions about mechanics at Pesaro is testified by the successive letter as well: Francesco Guerrini, architect and disciple of Guidobaldo, half a year after his master's death, approaches Clavius in order to clear a conceptual problem concerning the centre of gravity of plane figures:

> After the death of the Most Illustrious Guido dal Monte, may God rest his soul, several gentlemen of the city of Pesaro have asked me to show them the practice of Guidobaldo's *Le Mechaniche*, as I do. We have already finished the first book *Della Libra*, and at the beginning there has been a great controversy about the definition of the centre of gravity, about these words: "If a plane is drawn through this centre, intersecting the figure in an arbitrary way, so it will divide it always in equiponderating[1] parts."
> And if one wanted to insist in the wording "intersecting in an arbitrary way", it would seem that the two parts, after the section, would weigh equally, but in reality the contrary can be proven. (...)
> I beg You to let me know Your opinion which will be the greatest favour to me.[2]

Also two letters of Baldi to Pier Matteo Giordani permit to get information about the scholars' circle around Guidobaldo. On June 6th 1585, he wrote about his plan to undertake the trip from Guastalla to Urbino, in order to get ordained as a priest. In this context he expresses his desire to meet also with "Sir Guidobaldo, Sir Cesare <Benedetti>, Your Lordship <Pier Matteo Giordani>, and the other talented[3] gentlemen":

> After the arrival of the expedition, I will take the possession and will come to Urbino in order to ordained as a priest with Archbishop Gianotti; from there, I will get to Pesaro to enjoy a bit Sir Guidobaldo,

[1] "To equiponderate" is a neologism we have created in order to take into account the fact that the Latin notion "*aequeponderare*" does not correspond neither to the modern concept *moment*, nor to "to be in equilibrium": we deal with this problem in a more detailed way in Part B, chapter II. Cf., in particular, section II.4 and page 349

[2] Cf. APUG 529, fols. 112r-113v; 24th June 1607: "Dopo la morte dell'Ill.mo S.r Guido dal Monte, che sia in gloria, alcuni gentiluomini qui della Città di Pesaro m'hanno pregato ch'io voglia mostrar loro la prattica delle *Mechaniche* del suddetto S.re si come faccio. Che di già sta finito il primo libro *Della Libra* perché nel principio vi è stato molto disputa sopra la definitione de centrum gravitatis, sopra queste parole: *Si enim per tale centrum ducatur planum, figuram quomodocumque secans, semper in partes aequeponderantes ipsam dividet.* E veramente chi volesse stare in su la parola *quomodocumque secans*, pareria che sempre mai le due parti dopo l'averli fatta la settione che dovessero pessare egualmente ciascuna da per sé, ma in effetto si prova tutto al contrario (...). La prego a dirmene il giuditio Suo che mi sarà di sommo favore (...)." Published in Chr. Clavius, *Corrispondenza*, critical edition by U. Baldini and P.D. Napolitani, cit.

[3] Note the reappearance of the wording "talented": it might have been a denomination with which the group autoidentified itself.

> Sir Cesare <Benedetti>, Your Lordship, and the other talented gentlemen. (...) It will be a most remarkable favour if You kissed the hand of Sir Guidobaldo, my Lord, in my name, and also to Sir Cesare Benedetti and of all of them to whom I do not write expecting to write them after the thing will be determined and fixed.[1]

Already four years before, on November 4th 1581, Baldi had written a similar letter, again from Guastalla, telling that he would enjoy to stay close to Guidobaldo, Pier Matteo Giordani, Curzio Ardizi and others, which would have been one of the reasons for him to cancel a planned sojourn in Spain:

> Your Lordship, who is so lucky to be able to enjoy Sir Guidobaldo all day long – I know that You are with him the whole day – will hear from him about my resting in Italy, although it will not be a great effort to write it to You as well. (...) I know very well that, staying in Italy, I will enjoy Milan as well as Mantua as well as Sir Guidobaldo, as well as Sir Piermatteo <Giordani>, as well as Sir Curzio <Ardizi> as well as many other cities and men that I would not have met in Spain. And balanced by me according to the concept of *centre of gravity*, this equilibrates all Spain.[2]

In fact, shortly after his departure to Guastalla, Baldi expressed that the only thing he was missing at his new home were the conversations he had had at Pesaro – given the context he presumably referred (also) to the discussions of the circle around Guidobaldo.[3]
Another hint at the existence of such a circle is contained in a letter written by the latter to Muzio Oddi in 1600, also this time in a polemical style:

> Neither to Sir Pier Matteo <Giordani>, nor to Sir Count of Carpegna, I want to make a kiss on the hand, since I see all of You agreeing not

[1] Cf. BOP, ms 430, fol. 27r/v: "Venuta che sia la spedizione piglierò il possesso e poi me ne verrò a Urbino a ordinarmi dal Arcivescovo Gianotti e di là a Pesaro a goder un poco il S.r Guidobaldo, il S.r Cesare, V.S. e gl'altri gentiluomini virtuosi.(...) Mi sarà favore segnalatissimo se bacierà le mani in mio nome al S.r Guidobaldo mio Sig.re et anco al S.r Cesare Benedetti e di tutti loro che io non gli scrivo aspettando di scrivergli cosa di già determinata e stabilita."

[2] Cf. BOP, ms 430, fols. 25r-26v: "V.S. che ha in sorte di poter godere il Sig.r Guidobaldo tutto il giorno, se so che tutto il giorno anco debbe esser seco, intenderà da lui del mio restare in Italia, benché lo scriverlo anco a Lei non mi sarà molto di fatica. (...) So ben questa che stando in Italia goderò parte Milano, parte Mantova, parte il Sig.r Guidobaldo, parte il Sig.r Piermatteo, parte il Sig.r Curtio e parte molt'altre città e molt'altri uomini che io non averei trovato in Spagna; e bilanciati appresso di me sono secondo le ragioni del centro della gravità equilibri a tutta la Spagna."

[3] Cf. BOP, ms 430, fol. 19r/v (letter to Pier Matteo Giordani, 18th November 1580): "S'Ella desidera poi d'essere informata delle qualità del Sig.re, La legga quello ch'io scrivo al Sig.r Guidobaldo. Insomma io sto tanto bene che se io avessi qual<ch>e conversazioni di Pesaro non invidiarei il Papa. Però V.S. che può farmi parte delle cose di là con sue lettere non mi manchi di grazia a farlo, che facendolo ne resterò cresciuto il colmo degl'oblighi che io tengo seco."

> to come back down <to Pesaro> God knows when, so I will expect You God knows when.[1]

The impression gained by the precedent sources is confirmed by manuscript 758 of the Biblioteca Oliveriana (Pesaro), *the* fundamental biographical account of Guidobaldo's life:

> <Guidobaldo> took delight in discussing with various professors of these mathematical sciences; among them, the Bishop of Pesaro <Cesare Benedetti>, Sir Federico Bonaventura, Sir <Jacopo> Mazzoni, Sir Abbot of Guastalla <Bernardino Baldi>, Sir Galileo Galileo and Sir Pier Matteo Giordani: men of great merit.[2]

So, conclusively, we have seen among the members of Guidobaldo's circle Bernardino Baldi, Muzio Oddi, but also less known characters like Pier Matteo Giordani, Tommaso Count of Carpegna, Curzio Ardizio, Tibero and Virginio Almerici, Camillo Mazza, as well as the three philosophers Jacopo Mazzoni, Federico Bonaventura and Cesare Benedetti.[3] Further, he had around himself more technically oriented collaborators like Francesco Guerrini, Niccolò Sabbatini, Francesco Pacciotti, Simone Barocci, Count Giulio da Thiene, Girolamo Arduini and others.[4] Information on these persons, their life and work are exposed in Appendix II, II.1.

After the presentation of these documents regarding the existence of a scholars' circle around Guidobaldo, the question is of which nature this group of interlocutors and collaborators was. The sections IV.1.2 and V.1.2 of Part A will expose our hypothesis – and the respective sources by which it is supported – that in reality two different groups can be distinguished: one circle whose members were interested in mathematical and philosophical questions, the so called "philosophers" and "talented" men. And, on the other side, another group composed by architects, engineers and technicians, with more practical interests relative to the pursuing of their profession.

[1] Cf. BUU, Fondo Congregazione di Carità, busta 47, fasc. VI, fol. 952r (letter to Muzio Oddi, August 5th 1600): "Né al Signor Pier Matteo, né al Signor Conte di Carpegna non voglio far bascia mani, poiché vi vedo tutti d'accordo a non voler tornar già Dio sa quando, di modo che io vi aspetto Dio sa quando (...)."

[2] Cf. BOP, ms 758: "<Guidobaldo> ebbe poi anco caro il conversar con i più vari Proffessori di queste scienze matematiche fra quali furno Mons.r Vescovo di Pesaro, il S.r Federico Bonaventura, il S.r Mazzoni, Il S.r Abb.e di Guastalla, il S.r Galileo Galilei et il S.r Piermatteo Giordani, uomini di eccelse valore." For the transcription of the whole manuscript BOP, ms 758, see Appendix I, II.2.

[3] For further information about Guidobaldo's interaction with them and his interest in philosophy, cf. Part A, V.1.

[4] In regard of Guidobaldo's technical and architectural collaborators, cf. Part A, IV.1.2.

Chapter III

Short overview of the various traditions of sixteenth-century mechanics

The present chapter sketches out a short overview – obviously far from being complete and exhaustive, given the priorities of the present doctoral thesis – of mechanics in the sixteenth century: this will facilitate the comprehension of the following chapters dedicated to the description of Guidobaldo's treatises on mechanics. In fact, since they were embedded in a determinate context, the disregard of this circumstance would lead to a misinterpretation of central aspects of his work – as already happened in certain studies of his mechanics.[1]

Sixteenth-century mechanics was a fragmentary discipline constituted by distinct traditions which could only partly communicate with each other. The present chapter presents overviews of the ones which had the greatest impact on Guidobaldo's mechanical work: the tradition of the Aristotelian Quaestiones Mechanicae; *the mechanics of Archimedes; the tradition on mechanical machines going back to Heron and Pappus; the medieval* Scientia de Ponderibus; *the contributions of the sixteenth-century scholars Tartaglia, Cardano, Benedetti.*

[1]For example, the analysis of P. Duhem of Guidobaldo's work in *Origines de la Statique* is unilateral and does not take into account its context, like the incompatibility of Jordanus's mechanics with Archimedes's, against the background of the Marchigian mathematician's orientation towards the Syracusan's work. Another case is the often repeated critique forwarded by modern historiographers of mechanics against Guidobaldo that he had not accepted the (correct) result of Jordanus's proposition regarding the inclined plane: in the light of what we will expose in this chapter and in Part B, chapter I, this critique disregards central elements of Guidobaldo's and Jordanus's mechanics.

General reflections

The notion "sixteenth-century mechanics" might, at first sight, suggest the existence of something like a coherent body of knowledge regarding the explanation of mechanical objects and phenomena in the sixteenth century; in reality, however, it refers to the coexistence of single, often divergent traditions: they differed notably both in the environment where the respective studies were undertaken (universities, workshops of technicians, *milieus* of the Renaissance courts) as well as in the specific topics or areas which were accentuated. Another important characteristic of this body of knowledge is the fact that it gradually acquired the status as scientific discipline only in the course of that century.[1]

The universities were one – by far not the only – environment where questions were discussed which according to today's conception would be classified as relative to mechanics. In fact, the studies on philosophy in this context comprised also the occupation with natural philosophy, which on its part dealt, *inter alia*, with problems connected with motion. The debates in regard were fundamentally determined by the Aristotelian philosophy which conditioned the conception of the cosmos and the physical reality in the sixteenth-century in a decisive way.[2] In effect, throughout the sixteenth century, it represented the essential reference system for any debate on natural phenomena, particularly those regarding motion and its laws. Even if, from Antiquity through the Middle Ages until the Renaissance, some critiques had been forwarded against single elements of this system of the world, only in the late sixteenth and the seventeenth century the Aristotelian system began to be challenged in its very foundations: the geocentric system of the world (Copernicus, Galileo), the incorruptibility of heavens (novae, sunspots), the existence of crystal spheres (comets, Jovian moons) the non-existence of void, and the problems to explain such basic phenomena as the motion of projectiles were some of the elements that led more and more to conceptional difficulties. In the sixteenth century, however, it continued to represent the mental model that constituted the context of any debate on motion: even critical scholars in regard, like Benedetti and Galileo, continuously referred to

[1] For further information on the topic delineated in the present paragraph, cf. P.D. Napolitani, *Il Rinascimento italiano*, in C. Bartocci, P. Odifreddi (eds.), *La matematica*, vols. 4, vol. I, Einaudi, Torino, 2007.

[2] For further information on the Aristotelian natural philosophy, cf. the following studies: a very illustrating of it, which we substantially follow in the present section, is contained in A. Koyré, *Galileo Studies*, Hassocks Sussex, Harvester Press, 1978; English translation of *Ètudes Galiléennes*, Paris, Hermann, 1966. An equally interesting critique against the Aristotelian natural philosophy, still worth-reading, is G. Galileo, *Dialogo sopra i due massimi sistemi del mondo*, in Galileo, *Opere*, cit. Studies on the Aristotelian physics are W. Wieland, *Die Aristotelische Physik*, Göttingen, Vandenhoeck&Ruprecht, 1962; and A. Mansion, *Introduction à la physique aristotélienne*, Paris-Louvain, Alcan, 1913.

this reference system and its basic notions like *natural place*, as well as *natural* and *violent motion*.[1]

Another cultural framework condition that permitted the establishment and the diffusion of certain mechanical traditions was constituted by the recovery of ancient and medieval mathematics. At first, this phenomenon was connected with humanistic circles, like those related to Pope Niccolò V or to Cardinal Bessarione. On the basis of these works, practically all available texts of mathematics and mechanics had been printed and diffused in the sixteenth-century. The first in-depth studies of these texts which accompanied this publishing process of fundamental mechanical texts, for example of Archimedes (*Equilibrium of Planes*), Heron (*Mechanica*[2]) and Pappus (*Collectiones Mathematicae*) were generally connected to the *milieus* of the Renaissance courts, and enabled by their sovereigns' patronage. The recovery of the texts and their intellectual re-appropriation entailed the development of new mathematical and mechanical problems.
Two other fundamental texts of mechanics, recovered and printed in the sixteenth century, were the (pseudo-?)Aristotelian *Quaestiones Mechanicae*, dealt with also at the universities, and the three treatises *Elementa*, *De Ponderibus* and *De Ratione Ponderis* of Jordanus Nemorarius.

A third, not less important environment that favoured the occupation with questions relative to mechanics was represented by the world of the "technicians" who constituted, according to the notion created by C. Maccagni, the "intermediate cultural stratum":[3] their formation usually was not embedded in the context of the universities or courts, but typically in the environments of the so-called "*abacus*-schools". The learning acquired there placed them culturally between who had been taught in the *artes liberales* on the one hand, and the illiterates on the other. The body of knowledge of the technical tradition was handed down largely by oral transmission, in contrast to the studies undertaken in the environments of the universities or courts, typically during the apprenticeship and/or in the workshops. Yet, some parts of it were transmitted also by written texts, in

[1]Galileo, for example, seems to have felt the necessity, even in his mature years, to argue against the theory of his former professor at Pisa, the Aristotelian philosopher Francesco Buonamici (1533-1603); cf. M.O. Helbing, *La filosofia di Francesco Buonamici, professore di Galileo a Pisa*, Pisa, Nistri-Lischi, 1989.

[2]The *Mechanica* themselves were rediscovered only in the late ninteenth century (cf. section III.3); yet, extracts of them were contained in the *Collectiones Mathematicae*, which were published in 1588 by Commandino; again, cf. section III.3.

[3]The notion of *strato culturale intermedio* has been established by Carlo Maccagni. In regard, cf. C. Maccagni, *Leggere, scrivere e disegnare la "scienza volgare" nel Rinascimento*, in "Annali della Scuola normale Superiore di Pisa. Classe di Lettere e Filosofia", III 23, fasc. 2 (1993), pp. 631-675; C. Maccagni, *Cultura e sapere dei tecnici nel Rinascimento*, in *Piero della Francesca: tra arte e scienza*, eds. M. Dalai Emiliani, V. Curzi, Venezia, Marsilio, 1996, pp. 279-292.

works like Vitruvius's *De Architectura* or in the books of Biringuccio and Agricola on machinery used in mining and metallurgy; of Fontana, Agrippa and Pigafetta on the moving of the Roman obelisks; of Francesco di Giorgio Martini, Ramelli and others on machines in general. All in all, every-day problems of bombardiers, constructors of machines or scientific instruments, painters, architects formed a living and growing body of knowledge leading to new approaches to mathematical and mechanical topics; the respective solution proposals and techniques not rarely represented the starting point of "scientific" developments of the respective subjects.

These different traditions and environments began to communicate more and more with each other in the sixteenth century. One of the first scholars whose works is distinctly characterised by the intermixture of elements from various environments was Niccolò Tartaglia: closely related to the environment of the "technicians", he was also in contact with humanists like Diego Hurtado de Mendoza.[1] In his mechanical works, Tartaglia attempted to set up a geometrical model of the trajectory of the projectiles – a topic, thus, being part both of the daily occupations of the bombardiers, members of the "intermediate cultural stratum", as well as of the discussions relative to natural philosophy at the universities. He further revisited topics exposed in the texts of ancient and medieval mathematics and mechanics and edited works (or extracts of works) of Jordanus Nemorarius, Euclid and Archimedes. Significant for the convergence of the various mathematical traditions is Tartaglia's attempt to apply the Archimedean theory of buoyancy to the practical problem of sunken ships.
Yet, the Brescian mathematician was still far away from coming to a synthesis between the several textual traditions, confining himself often to juxtapose (even contradictory) theories; nor did he deal in a detailed way with an important topic of sixteenth-century mechanics, namely with mechanical machines. It is Guidobaldo dal Monte who assumed a role of significance regarding the attempt of a synthesis between them: in his *Mechanicorum Liber*, he elaborated a mathematically consistent theory of the topic of Simple Machines, which goes back to Heron and Pappus, by founding his argumentations on the Archimedean concept of *centre of gravity*. In this context, he evidenced that Jordanus's theory was *incompatible* with Archimedes's.In his work *Paraphrasis*, he further stressed that Archimedes's mechanics could be conciliated with elements of the Aristotelian natural philosophy and with the theory exposed in the *Quaestiones Mechanicae*. An important part of what was to constitute modern mechanics, however, was approached substantially with diffidence by Guidobaldo: phenomena concerning motion. Important contributions in this regard were given by Cardano and particularly Benedetti. Then, it was Galileo who approached the construction of a

[1]Mendoza, ambassador of Emperor Charles V, was also poet and translator of the *Quaestiones Mechanicae* in Spanish.

geometrical model of motion: he attended to systematic studies on pendulums, inclined planes and on the force of impact and discovered the proportionality between space and the square of time. But large parts of these studies date already back to the seventeenth century.
The importance of sixteenth-century mechanics for the genesis of modern physics might be considered to consist notably in the fusion, or at least in the attempts to come to a synthesis, of the divergent traditions that have been delineated in the present paragraph.

Evidently, a detailed analysis of the just outlined situation would be highly complex and would require much more place, not to speak of competencies, as the present doctoral thesis can offer. Instead, the following sections intend to present a short overview of those mechanical traditions and ideas which had a direct and notable impact on Guidobaldo's work. This inevitably leads to pass over important contributions to sixteenth-century mechanics like those of Maurolico, Stevin or Varro, which is not intended, however, to diminish their importance.

III.1 The (pseudo-?)Aristotelian *Quaestiones Mechanicae*[1]

The *Quaestiones Mechanicae* represents the first extant treatise of mechanics. It is dedicated to the explanation of elementary mechanical problems, exposed in the form of 35 questions and their respective answers. The debate on the authorship of the text is still open, some scholars attribute it to Aristotle (384-322 BC) personally, other consider it as a work of one of his disciples.[2]

A part of the approached problems treats phenomena related to basic mechanical machines like balance, lever, pulley, winch, wedge or devices like rollers or carts: so, the author approaches the problems why large balances would be

[1]Here is not the place to analyse the treatise thoroughly. For further informations on it and its reception, cf. the following contributions: a comparison of the Aristotelian writing with the Archimedean and Heronian tradition is approached by F. Krafft, *Dynamische und statische Betrachtungsweise in der antiken Mechanik*, Wiesbaden, Steiner, 1970; a complementary and contrasting study is G. Micheli, *Le origini del concetto di macchina*, Firenze, Olschki, 1995. On the reception of the work in the Renaissance see P.L. Rose, S. Drake, *The Pseudo-Aristotelian* Questions in Mechanics *in Renaissance Culture*, in "Studies in the Renaissance", XVIII, 1971, pp. 65-104. M.O. Helbing analyses the influence of the text on Galileo's work, cf. *Galileo e le* Questioni Meccaniche *attribuite ad Aristotele. Alcune indicazioni*, in *Largo campo di filosofare. Eurosymposium Galileo 2001*, J. Montesinos, C. Solis (eds.), La Orotava, Fundación Canaria Orotava de Historia de la Ciencia, 2001, pp. 217-236. English translations of the text are presented by E.S. Forster, Oxford, Clarendon, 1952 or W.S. Hett, *Aristotle in twenty-three volumes. XIV: Minor works*, Cambridge, Harvard University Press, 1980.

[2]Here, for the sake of brevity, it will be called an "Aristotelian" writing.

more accurate than small ones (Q.I), why balances act differently according to the position of their supports (Q.II), why a lever or a double pulley are able to raise great weights with the exercise of little force (Q.III and Q.XVIII), why a winch is easier to move with long bars (Q. XIII), why a wedge can exert great pressure and split large masses (Q.XVII), and why heavy weights are more easily conveyed on rollers than on carts (Q.XI). A series of ulterior questions deals with related problems, concerning applications of the aforesaid machines like forceps (Q.XXI), nutcrackers (Q.XXII) or timber-beams beard on shoulders (Q.XXVI and XXVII).
Another group of questions (Q.IV-VII) deals with problems relating to nautics: why rowers who are amidships would contribute most to the movement of a ship, why a small rudder moves a large ship with little force or why a ship travels quicker the higher the yardarm is raised.
Further, the treatise approaches the explication of phenomena connected with motion: why spherical and circular bodies are easier to move than others (Q.VIII), why missiles travel further from a sling than from the hand (Q.XII), why a body which is already in motion is easier to move than another which is at rest (Q.XXXI), why a body is carried on by a motion impelled by a force that does not keep following it and pushing it along (Q.XXXIII).

An important part of the work is constituted by its preface: it opens with a juxtaposition of nature and art: by means of mechanics, mankind can produce effects that would not happen naturally, as they are παρὰ φύσιν.[1] Mechanics is presented as holding the status of a scientific discipline – this would have been important particularly in the course of the work's reception in the sixteenth century: the classification as science, moreover stated by the authority of Aristotle,[2] perceptibly contributed to a higher consideration of mechanics. It would take into account physical objects and phenomena relating them to geometrical principles: so it is presented as a "subalternate" science depending on natural philosophy and mathematics, like astronomy or optics.[3]
The *leitmotiv* of the introduction are the "marvels" produced by mechanics: so, the author wonders why a weight that is too heavy for being lifted without any device can be moved with a lever, increasing, by doing so, its weight additionally. But, as the author explains, "there is nothing strange in a lesser marvel being caused by a greater marvel, and it is a very great marvel that contraries should

[1]The notion παρὰ φύσιν gave rise to ample discussions in the sixteenth-century, more precisely on the meaning of παρὰ as *against* or *outside* (nature).

[2]In the sixteenth century, the authorship of Aristotle was not called in question, in substance.

[3]Cf. W.S. Hett, cit.: "These <mechanical problems> are not altogether identical with physical problems, nor are they entirely separate from them, but they have a share in both mathematical and physical speculations, for the method is demonstrated by mathematics, but the practical application belongs to physics."

be present together, and the circle is made up of contraries".[1] It is in this way that the treatise's fundamental "principle of the unequal concentric circles" is introduced:

> Now if of two objects moving under the influence of the same force one suffers more interference, and the other less, it is reasonable to suppose that the one suffering the greater interference should move more slowly than that suffering less, which seems to take place in the case of the greater and the less of those radii which describe circles from the centre.[2]

On this basis, the operation mode of the lever is motivated: a smaller weight, further from the centre, describes the greater circle than a bigger one in a nearer distance from the fulcrum. The former is, thanks to his "greater movement",[3] able to counterbalance the latter if the two weights are in a "certain relation" with one another: most of the translators interpreted the respective passage as statement of the law of the lever, while a linguistic analysis seems to confute this.[4]

The main part of the writing resembles to a compendium with observations relative to common sense. The general stile of the answers is qualitative, given the substantial absence of argumentations having recourse to mathematics; further, the treatise does not present any axiomatic-deductive structure.
It is not entirely cleared which influence the treatise had in antiquity: while some scholars hold that it had a strong impact on Heron's *Mechanica*, other studies argue that the similarities between these two works were limited to a superficial level and that the work in reality remained substantially unknown in antiquity.[5]
Then, as far as the Middle Ages are concerned, M. Clagett claims that no medieval translation of the text was known, neither in Arab nor in Latin.[6]
Its reception fundamentally changed in Renaissance: in the sixteenth-century, there was a downright boom of Latin and vulgar translations of and commentaries on the work, beginning with the Latin translations of Vittore Fausto (1517) and

[1] Cf. E.S. Forster, cit.; Arist., *Mech.* 847 b 16-20.

[2] Cf. W.S. Hett, cit.; Arist., *Mech.* 849 a 6-11.

[3] Cf. W.S. Hett, Question III (on the lever), cit.; Arist., *Mech.* 850 b 5-7.

[4] The critical term in question is ἀντιπέπονθεν: on the problem of its translation, cf. G. Micheli, *Le origini del concetto di macchina*, cit., pp. 80-83. Anyway, even if one would concede the translation as "reciprocal", this statement would seem a later addition: despite of its fundamental relevance, it remains unproven and is not used elsewhere in the writing.

[5] This latter position is held by G. Micheli, *Le origini del concetto macchina*, cit., pp. 115-119. Carra de Vaux, Marshall Clagett and Fritz Krafft, instead, consider Heron's *Mechanica* as testimony of the impact that the *Quaestiones Mechanicae* had on antique mechanics.

[6] M. Clagett, *The Science of Mechanics in the Middle Ages*, Madison, University of Wisconsin Press, 1959. Italian translation *La scienza della meccanica nel medioevo*, Milano, Feltrinelli, 1972, p. 22: "l'opera nota col titolo *Mechanica* è della massima importanza per la storia della statica, pur non conoscendosene alcuna traduzione medievale né in arabo né in latino".

Niccolò Leonico (1525); other important commentaries of the text were edited by Alessandro Piccolomini (1547), Henri de Monantheuil (1599), Bernardino Baldi (1621) and Giovanni di Guevara (1627).[1] In this process, the reading itself of the text changed: first, a certain accentuation of its connections with natural philosophy can be discerned, afterwards the general interest shifted more and more to the actual mechanical problems like the strength of material etc.
So, certain elements and aspects of the writing had notable effects on the scientific debate on mechanics. It has been argued,[2] for example, that Galileo's mechanics has received some inspiration by the Aristotelian text: amongst them, the so-called *compensation principle* for the Simple Machines, the composition of forces and the idea that a perfectly smooth sphere on the horizontal plane is moved by a arbitrarily small force. Guidobaldo, on his part, had apparently frequented lectures on this treatise at the University of Padua, cited it several times in his writings and revisited some of the exposed problems in his *Meditatiunculae*.[3]

[1]Other authors, dealing with the Aristotelian text were: Diego Hurtado de Mendoza, Niccolò Tartaglia, Francesco Maurolico, A. Wechel, Antonio Guarino, Giuseppe Moletti, Giovanni Battista Benedetti, Joseph Blancanus. Cf. P.L. Rose, S. Drake, *The Pseudo-Aristotelian* Questions in Mechanics *in Renaissance Culture*, cit.

[2]Cf. M.O. Helbing, *Galileo e le* Questioni Meccaniche *attribuite ad Aristotele. Alcune indicazioni*, cit. Helbing's argumentation is interesting and clear. Regretfully, he does not take into account Guidobaldo's influence on Galileo, particularly on *Le Meccaniche*.

[3]For further information about the *Meditatiunculae*, cf. Part A, VI.

III.2 Archimedes's mechanics[1]

The mechanical theory of Archimedes is fundamentally different from the model presented in the *Quaestiones Mechanicae*, and is exposed in several treatises: his main writing on mechanics is the *Equilibrium of Planes*, but also the *Floating Bodies*, the *Quadrature of the Parabola*, and the *Method*[2] contain argumentations relative to this mathematical branch.

The *Equilibrium of Planes*, divided in two books, presents an axiomatic-deductive structure. It begins with the exposition of seven axioms, referring to weights and geometrical figures, their centres of gravity – the fundamental concept of the Archimedean approach to mechanics – and their properties on balances. The first part of Book I contains the first extant demonstration of the law of the lever: its qualitative version is proved in Propositions I-III, the quantitative one in Proposition VI and VII. The second part of the first book deals with the determination of the barycentres of parallelogram, triangle and trapezium. Book II is entirely dedicated to the rather complex determination of the parabola-barycentre. The treatise hence does not deal with mechanical machines or phenomena which seem to have a direct application in the physical world. In contrast, it considers abstract geometrical bodies: the regarded balances, emblematically, are imagined as lines connecting the centres of gravity of the objects in question. A mechani-

[1]For further information, cf. the following studies: on Archimedes's life and work, cf. E.J. Dijksterhuis, *Archimedes*, Amsterdam, Meulenhoff, 1938. Another interesting overview on the Archimedean *corpus* and its tradition is given in P.D. Napolitani, *Archimede. Alle radici della scienza moderna*, in "I grandi della scienza", Le Scienze, Milano, 2001. G. Vailati (*Del concetto di centro di gravità nella statica d'Archimede*, in *Scritti di G. Vailati (1863-1909)*, Leibzig/Firenze, Barth/Seeber, 1911) and A.G. Drachmann (*Fragments from Archimedes in Heron's* Mechanics, in "Centaurus", VIII, 1963, pp. 91-146) approach the problem of a hypothetical reconstruction of an axiomatic theory of the barycentre, starting from the *Equilibrium of Planes*, combined with references in Pappus and Heron. E. Mach (*Die Mechanik in ihrer Entwickelung historisch-kritisch dargestellt*, Leipzig, Brockhaus, 1901) expressed doubts on the logical correctness of Archimedes' prove of the law of the lever, contested by Dijksterhuis in *Archimedes*, cit. Remarkable is the contribution of J.L. Berggren (*Spurious Theorems in Archimedes' Equilibrium of Planes Book I*, in "Archive for History of Exact Sciences", XVI, 1976, pp. 87-103) which proves that Book I of the *Equilibrium of Planes* with all probability is not genuine. A contrasting opinion is contained in W.R. Knorr, *Archimedes and the pre-Euclidean proportion theory*, in "Archives internationales d'histoire des sciences", XXVIII (1978), pp. 183-244. For the rediscovery and intellectual re-appropriation of Greek mathematics, in particular of the Archimedean *corpus*, cf. P.L. Rose, *The Italian Renaissance of Mathematics*, Ginevra, Droz, 1975. Information on the works on the Archimedean palimpsest is contained in R. Netz, W. Noel, N. Tchernetska, N. Wilson, *The Archimedes Palimpsest*, 2 vols., Cambridge, Cambridge University Press, 2011.

[2]As is well-known, however, the *Method* does not seem to have been known until the beginning of the twentieth century. For the focus of the present chapter to mechanics (and its writings) in the sixteenth century, this work will be described only marginally, cf. footnote 4 on page 92.

cal principle (law of the lever) is used, after having been demonstrated, in order to determine geometrical properties of mathematical objects, namely the the barycentres of various figures.
Correspondingly, the argumentations are strictly mathematical-geometrical: it is the working concept *centre of gravity* that permits to treat physical phenomena on the basis of geometrical argumentations.

In its transmitted form, the treatise presents, however, a couple of problematic aspects and notable incongruities:[1] conceptually most grave is the absence of the definitions of the basic notions *centre of gravity* and ἰσορροπία as well as the fact that their reciprocal dependencies are not specified: these circumstances entail that the precise argumentative-conceptual structure is not entirely cleared.[2]

In Renaissance, this situation lead to several approaches to reconstruct Archimedes's theory, producing remarkably different results. Among the most relevant, there are those of Maurolico (*De Momentis aequalibus*, of Guidobaldo (*Paraphrasis*) and, to some extent, of Galileo (*Le Mecaniche*).[3]

Further information on Archimedes's mechanical theory is deducible from the *Quadrature of the Parabola*. There, the Syracusan mathematician determines the area of the parabola, comparing it with the inscribed triangle having the same basis and height, by stating their relation as 4 to 3. Before this result is proved geometrically in the second part of the writing, Archimedes first adopts argumentations relative to mechanics – treating the respective geometrical figures as weights proportional to their area, applying them to a balance and using the law of the lever – hence, with a proceeding similar to the one adopted int he *Equilibrium of Planes*. From this context, important properties of the concepts *centre of gravity* and equilibrium can be deduced.[4]

[1]For further information on this aspect, cf. J.L. Bergren, *Spurious Theorems in Archimedes' Equilibrium of Planes Book I*, cit.

[2]Further, there is a strange terminological inconsistency regarding the denomination of the considered objects (*weights*, *figures*, *magnitudes*). Also the role of certain axioms gives rise to some ambiguity: some of them do not seem to have any function in the argumentation line of the book, another one is not used at all, while the validity of yet another is proved in two special cases. As far as the propositions are concerned, the situation is similar: some of them, including *Aliter* or corollaries, seem incongruous with the rest, probably constituting subsequent additions. Significantly, some of the demonstrations are inconclusive. Surely, a part of these problems is owed to the corruption of the text in the course of its transmission. Yet, beyond, it has been convincingly argued that the treatise, in the form we know it, probably is not genuine, but has undergone massive modifications. Again, cf. J.L. Bergren, *Spurious Theorems in Archimedes' Equilibrium of Planes Book I*, cit.

[3]A more detailed overview of these approaches is exposed in Part B, II.3. For further information on Guidobaldo's *Paraphrasis*, cf. Part A, V.

[4]Particularly important, in regard, is the reasoning of Proposition VI. Further, also the *Method* deals, *inter alia*, with the search of the barycentre of the parabola and contains important aspects of Archimedes's mechanical theory, but was unknown in Renaissance, cf. P.D.

The treatise *Floating Bodies* states the law of buoyancy, the so-called "Archimedes's principle", and determines the conditions of equilibrium of a spherical segment and of a segment of a paraboloid immersed in a liquid. The axiom which introduces the writing, specifying the direction of the pressure exerted by the liquid, suggests that Archimedes's model refers to enormous quantities of liquids, i.e. to the sea.[1]

Some writings of Archimedes were known in the Middle Ages, but it does not seem that the studies in regard reached a full comprehension of the texts or that its reception went beyond singular, isolated cases.[2] It was only in Renaissance, especially in the second half of the sixteenth century, also thanks to the increased diffusion thanks to the printing press, that there took place intensive studies of the Archimedean *corpus*. Numerous (often partial) editions testify the interest towards these texts, for example, by Luca Gaurico (1503), Niccolò Tartaglia (1543), Venatorius's *Editio princeps* of Basel (1544) or Commandino's *Opera Archimedis nonnulla* (1558). These editions marked the starting point for in-depth studies on the Archimedean treatises, permitting the development of new research topics, like on the *centres of gravity* of solids or on the *indivisibles*. This process, from the restoration of the texts and, on this basis, to the statement and solution of new scientific questions, usually is called *Archimedean revival*.

Napolitani, *Archimede*, cit. It is an exceptional work giving insight in the heuristic methods with which Archimedes had found some of his results. The approach applied in the first part of the *Quadrature of the Parabola* and in the *Equilibrium of Planes* – the use of the law of the lever in order to prove properties of geometrical figures – is adopted to many other, partly most complex problems: the barycentres of hemisphere and semi-ellipsoid and the volumes of sphere, ellipsoid, paraboloid and other more complex bodies.

[1] In this regard, the textual tradition of the passage in question is highly interesting: a corruption of the text lead to a different sense of the passage, conditioning scholars like Galileo, Stevin or Pascal. Cf. P.D. Napolitani, *I grandi della scienza: Archimede*, cit.

[2] Cf. the monumental work of M. Clagett, *Archimedes in the Middle Ages*, cit.

III.3 Mechanical machines and their construction: Heron and Pappus[1]

Yet another mechanical tradition to be revived in the sixteenth century goes back to antiquity: it dealt with mechanical, including pneumatic, machines and their construction, an aspect missing in the extant writings of the Aristotelian and Archimedean traditions that we have seen in the precedent sections. It is associated with the names of Heron (1st or 3rd cent. AD) and Pappus (4th cent. AD), both scholars active at Alexandria.

A central work of this tradition is Heron's *Mechanica*. It is divided in three books: the first contains the description of a machine called βαρούλκος, able to lift huge weights; a treatment of the problem of two mean proportionals; an analysis of the inclined plane and of problems connected with the concept *centre of gravity*. The second book contains a treatment of the five Simple Machines – lever, pulley, winch, wedge and the screw (the last one is not treated in the *Quaestiones Mechanicae*) – and seventeen mechanical problems exposed in form of questions and answers, resembling the Aristotelian treatise regarding their content: this similarity is one of the arguments for the hypothesis of a possible influence of the *Quaestiones Mechanicae* on Heron's *Mechanica*. Its third book then deals with the construction of mechanical machines.
The *Mechanica* had no direct influence on sixteenth-century mechanics: it has survived exclusively in an Arabic translation which was rediscovered only in the

[1]For further informations, cf. the following studies: a fundamental study on Heron's mechanics and its context is B. Vitrac, *Mécanique et mathématiques à Alexandrie: le cas de Héron*, Oriens-Occidens, 2010; two interesting, and contrasting studies of Heron's *Mechanica* are F. Krafft, *Dynamische und statische Betrachtungsweise in der antiken Mechanik*, cit., and G. Micheli, *Le origini del concetto di macchina*. A study on Heron's extant works and their impact on Renaissance mechanics is W.R. Laird, *Hero of Alexandria and Renaissance Mechanics*, in L.B. Cormack, *Mathematical Practitioners and the Transformation of Natural Knowledge in Early-Modern Europe*, Chicago, University of Chicago Press, in press. For a recent study on the *Mechanics*, cf. M.J. Schiefsky, *Theory and Practice in Heron's* Mechanics, in W.R. Laird, S. Roux (editors), *Mechanics and Natural Philosophy Before the Scientific Revolution*, New York, Springer, 2008. A cardinal study of Heron's *Pneumatica* is M. Boas, *Hero's* Pneumatica. *A Study of its Transmission and Influence*, in "Isis", XL (1949), pp. 38-48; its reception in sixteenth-century Italy is analysed in O. Trabucco, *L'opere supende dell'arti più ingegnose*, Firenze, Olschki, 2010. A French translation of Heron's *Mechanica* is Carra du Vaux, *Les Mécanique de Héron d'Alexandrie*, in "Journal Asiatique", IX 1-2, 1893; the (Greek-German) critical edition of Heron's *Mechanica* is edited by Nix&Schmidt, in the third volume of *Heronis Alexandrini Opera quae supersunt omnia*, eds. J.L. Heiberg, O. Nix, W. Schmidt, H. Schoene, vols. 5, Leipzig, Teubner, 1899-1914; the critical edition of the eighth book of Pappus's *Collectiones Mathematicae* is contained in the third volume of *Pappi Alexandrini collectionis quae supersunt*, ed. by F. Hultsch, vols. 3, Berlin, Weidmann, 1876-78.

late nineteenth century.[1] So, it was only thanks to the eighth book of Pappus's *Collectiones Mathematicae*, which exposes a summary of the Heronian treatment of the Simple Machines, that this part of Heron's treatment of them did not fail to have a notable impact on sixteenth-century mechanics.[2] The Pappian work was known in several manuscript copies in the second half of the sixteenth century. Then, in 1588, it was posthumously edited in the Latin translation of Federico Commandino, in a version revised by Guidobaldo.
However, the eighth book of the *Collectiones Mathematicae* is and was important not only for its conservation of Heron's theory of the Simple Machines: it further conserves relevant information on the Archimedean theory of the barycentres: it is there that the only antique definition of *centre of gravity* has survived. Further, it contains also an (erroneous) treatment of the inclined plane.

Besides the *Mechanica*, three other mechanical works of Heron were/are extant: the *Pneumatica*, in two books, which describes the principles and the construction of a number of machines operated by water and air pressure; the *Automata*, concerning with the construction of two weight-driven puppet theatres; and the *Belopoiica* dealing with the building of a crossbow and two catapults.
Of these, the *Pneumatica* probably was the most important.[3] It begins with a theoretical consideration of pressure in fluids, exposing in this context a theory of the interparticulate void, which constituted an important source of matter theory in the seventeenth century, and was in contrast to the Aristotelian doctrine of the non-existence of the void. There follows the description of a series of mechanical devices, like singing birds, puppets, coin-operated machines, a fire engine, a water organ, and the so-called *aeolipile* (a steam-powered engine, consisting of a sphere mounted on a boiler by an axial shaft with two canted nozzles that produce a rotary motion as steam escapes). After the circulation of Greek and Latin manuscript versions in the sixteenth century, it was again Federico Commandino who approached the treatise's edition. However, he did not succeed in completing the publication before his dead in 1575: it was only his son-in-law, Valerio Spaccioli, who released the Latin translation still in the same year, entitled *Heronis Alexandrini Spiritalium Liber*. The first Italian translation of the *Pneumatica* to be printed, in 1589, was made by the hydraulic engineer Giambattista Aleotti.[4] Only three years later, another Italian edition followed, made by

[1] It was first published by Carra du Vaux, *Les Mécanique de Héron d'Alexandrie*, in "Journal asiatique", IX 2, 1893.

[2] This is not the only merit of Pappus's *Collectiones Mathematicae* which turned out to be an extraordinary fertile text, above all the seventh book with its exposition of the analysis and synthesis. It was a problem stemming from there dealt by Descartes in his *Géometrie*.

[3] In this and the following paragraph, we expose large parts of W.R. Laird, *Hero of Alexandria and Renaissance Mechanics*, cit.

[4] For information on the interesting figure of Aleotti, cf. A. Fiocca (ed.), *Giambattista Aleotti e gli ingegneri del Rinascimento*, Firenze, Olschiki, 1998.

Alessandro Giorgi, a disciple of Commandino at Urbino. Also the *Automata* were translated into Italian by another scholar connected to the "School of Urbino", Bernardino Baldi. He printed this work in 1589 under the name *Degli Automati, overo Machine se moventi*. He translated also Heron's *Belopoiica*, publishing it in 1616.

The eighth book of Pappus's *Collectiones Mathematicae*, and therefore indirectly also parts of Heron's *Mechanica*, exerted a remarkable influence on sixteenth-century mechanics, through Guidobaldo dal Monte's revisiting, reorganisation and elaboration of the topic in his *Mechanicorum Liber* (1577), as well as indirectly through the influence of Guidobaldo's work on *Le Meccaniche* of Galileo. Heron's other books had less impact, stimulating rather curiosity and amusement that concrete scientific progress: despite of the description of important pneumatic and hydraulic devices in the *Pneumatica*, the working principles of this branch appeared to be fundamentally different from those of the mechanical machines and, consequently, could not be brought under the common principles of the rest of mechanics. They consequently were classified rather as entertainments and magic-working. – Heron's theory of pneumatics as well as the theory of matter and the void had to await the seventeenth century before their full effects were felt. On the other hand, the *Belopoiica* was impractical because it described how to build obsolete weapons, as well as the *Automata* taking into consideration (ingenious) toys.

III.4 The medieval *Scientia de Ponderibus*: Jordanus Nemorarius[1]

Another tradition with a considerable impact on sixteenth-century mechanics was the medieval *Scientia de Ponderibus*, mainly represented by the work of Jordanus Nemorarius (13th cent.?). Modern historiography of mechanics tends to attribute three mechanical treatises to him:[2] the *Elementa*, *De Ponderibus*, and *De Ratione Ponderis*.

[1]There obviously were other exponents of the *Scientia de Ponderibus* as well, like Albert of Saxony. Yet, for the importance of Jordanus in the debate of sixteenth-century mechanics, we will concentrate on his work in the present section. For further information on his mechanics, cf. the following studies: introductions to and transcriptions of Jordanus's writings are contained in E. Moody, M. Clagett, *The Medieval Science of Weights*, Madison, The University of Wisconsin Press, 1960. A fundamental, but unfortunately unilateral analysis of Jordanus is P. Duhem, *Les Origines de la Statique*, vols. 2, Paris, Hermann, 1905. A more critical analysis of Duhem's views are exposed by G. Vailati, *P. Duhem. Les Origines de la Statique*, in *Scritti di G. Vailati*, Firenze, Successori B. Seeber, 1911, pp. 684-688; another article which is exceptionally suitable to accompany the lecture of Duhem is the contrasting study B. Ginzburg, *Duhem and Jordanus Nemorarius*, in "Isis", XXV 2 (1936), pp. 341-362.

[2]The question of the authorship of the three writings *Elementa*, *De Ponderibus* and *De Ratione Ponderis* is controversial. We follow the attribution of Moody&Clagett, cit. Duhem holds a different view.

They deal with problems relative to the balance (law of the lever, angular and isostatic balances, etc.). *De Ratione Ponderis* moreover attends to questions connected with the resistance of media against weights, or with the laws of motion in air or in fluids. Furthermore, it contains an analysis of the inclined plane and presents, for the first time, its correct law, thus going beyond the achievements of (the extant part of?) antique mechanics.

The *Elementa* present a deductive-axiomatic structure, paired with a mathematically rather high level of prove techniques. They start with the statement of seven axioms, putting into relation weights and their motion: Axioms IV and V formalise the key concept of the treatise, called *gravitas secundum situm*: a weight is heavier positionally, when, at a given position, its path of descent is less oblique. And the grade of obliquity of the descent is determined by its vertical component. Particularly interesting is the treatment of the isostatic balance – i.e. an idealised balance with its rotation centre situated on the beam itself – in Theorem II, which would have given rise to a vehement debate in the sixteenth century.[1] Jordanus states that the balance, with equal weights suspended in equal distances, turns parallel to horizon, when previously moved in an arbitrary inclined position and then released. Then, the eighth theorem states the law of the lever, expressed in the terminology of the *gravitas secundum situm*: weights with gravities indirectly proportional to their distances from the fulcrum have positionally equal gravity. Strangely, the working concept in the demonstration does not seem to be the *gravitas secundum situm*, but another implicit reasoning that has anachronistically interpreted as foreshadow of the concept of *virtual works* in Jordanus.[2]

De Ponderibus exposes the same seven postulates, as well as the first nine propositions as the *Elementa* – slightly different wordings aside. Their demonstrations, however, lack the mathematical approach and precision of the aforesaid writing, being rather qualitative comments. On the contrary, it contains two important elements absent in the *Elementa*: firstly, its preface shows the author's familiarity with certain elements of the Aristotelian natural philosophy, like the notion of subalternate sciences or the distinction of violent and natural motions: in this context, the concept *gravitas secundum situm* is explained by being put into relation exactly with the movement's grade of violence. Secondly, *De Ponderibus* adduces four additional theorems (Prop. X-XIV) on real balances.

[1] A detailed analysis of Jordanus's treatment, in comparison with different theories in regard is exposed in Part B, chapter I; cf. particularly subsection I.1.1.

[2] Cf. P. Duhem, *Les Origines de la Statique*, cit. A confutation of Duhem's claims out of context is B. Ginzburg, *Duhem and Jordanus Nemorarius*, cit.

De Ratione Ponderis, a remarkable treatise regarding the achieved results, starts with the same seven axioms as the other two writings and contains not less than 45 theorems. They are arranged in four books and include some of the nine exposed in the *Elementa*, but also propositions on completely different topics, amongst them Theorems VIII-X:
The eighth one presents a correct analysis of the angular balance, in contrast to the erroneous version of Proposition VI in the *Elementa*. The next two propositions treat the inclined plane: the ninth states that the effective weight of a body does not change according to its position on the inclined plane. Theorem X claims that weights, being in the same ratio as the length of the inclined planes on which they are situated (presenting the same height), have "equal force in descending" – this statement is equivalent to the correct law of the inclined plane according to which the effective weight of a body on an inclined plane is given by the product of the gravity of weight and the sine of the basis-angle. Thus, *De ratione ponderis* is the first writing that enunciates this law correctly, in contrast to the treatises of Heron and Pappus. Its demonstration, however, does not seem thoroughly clear and, once again, it is not the *gravitas secundum situm* that is used in the prove, but the same implicit, not formalised reasoning as in the prove of the law of the lever in the *Elementa*.
Book II consists of 12 theorems attending to the study of real balances. The third part, counting six theorems, exposes statements about balances manifesting stable or unstable equilibrium, and about the problem of the effective weight of a rotatable beam in function of its inclination.[1] Book IV deals with completely different problems, connected with the elasticity of bodies, with the resistance of a medium to bodies in motion, or questions related to the velocities of bodies which fall in air or in fluids.

Jordanus's works had a remarkable fortune, both before and after the diffusion of printing press: a (relatively) conspicuous number of some thirty manuscripts survived until now. Then, both *De Ponderibus* and *De Ratione Ponderis* were printed in the sixteenth century: in 1533, Peter Apian edited the thirteen-proposition-writing under the name *Liber Iordani de Ponderibus*, so Jordanus's treatise constituted one of the first mechanical writings ever printed. The German mathematician must have consulted, though, also a manuscript descending from the *Elementa*-tradition, since he often adduces "*aliud commentum*" which strongly resemble the mathematical demonstrations exposed in the nine-proposition-writing. The figures used by Appian seldom are useful, in particular those regarding the last four propositions, which must have complicated the comprehension of the treatise.

[1]Duhem interpreted the proposition in question, the fifth of the third book, as testimony of the existence of the notion *moment* in Jordanus. Again, B. Ginzburg, *Duhem and Jordanus Nemorarius*, cit., has proved that this interpretation lacks any sound foundation.

De ratione ponderis was edited in 1565 under the name *De Ponderositate*, by Curzio Traiano, who had recourse to material left by Niccolò Tartaglia.[1] The quality of the edition, again, was not very high: sometimes the figures do not flank the correspondent propositions, and even the "new figures" realized by Tartaglia often contain errors – possibly due to the incomplete status of the works, given the death of the Brescian mathematician in 1557. Nevertheless, the Tartaglia-Traiano-edition presented considerable advantages compared to Apian's: it contains the corrected proposition on the angular balance, an amplified treatment of the isostatic balance and in particular the first correct statement of the law of the inclined plane.
Guidobaldo was particularly critical with Jordanus's work, considering its very conceptional foundation, the *gravitas secundum situm*, not to be true.[2] In fact, in his treatment and subsequent defence of his theory of the isostatic balance, the Marchigian mathematician evidenced that Jordanus's mechanical theory was not compatible with Archimedes's which constituted, in contrast, the model that had to be followed according to Guidobaldo.[3]

III.5 Tartaglia, Cardano and Benedetti: important sixteenth century scholars of mechanics

Niccolò Tartaglia[4]

Tartaglia (1499/1500-1557), particularly noted for his contributions to the solution of third-degree equations, was also one of the most important scholars of mechanics in the sixteenth century. His results in regard are exposed in the *Nova scientia* (1537) and in the *Questioni et inventioni diverse* (1546).

[1] In fact, the complete title reads *Iordani opusculum de Ponderositate Nicolai Tartaleae studio correctum novisque figuris auctum.*

[2] Cf. Guidobaldo, *Paraphrasis*, p. 19: "Ac propterea neque inter Mechanicos videtur mihi Iordanus ille esse recensendus. Quapropter ad Archimedem confugiendum est, si fundamenta mechanica, veraque huius scientiae principia perdiscere cupimus."

[3] For a more detailed analysis of this topic, cf. Part B, chapter I.

[4] For further information on the topic, cf. the following studies: S. Drake, I.E. Drabkin, *Mechanics in Sixteenth-Century Italy*, Madison, The University of Wisconsin Press, 1969. A. Masotti, *Tartaglia, Niccolò*, entry in "Dictionary of Scientific Biography", Ch.C. Gillispie (edit.), New York, Scribner's Sons, 1980. For an overview on his work, cf. A. Koyré, *La dynamique de N. Tartaglia*, in "La science au seizième siècle – Colloque international de Royaumont 1957", Paris, Hermann, 1960, pp. 93-113. Tartaglia's ballistics is discussed in A.R. Hall, *Ballistics in the seventeenth century*, Cambridge, Cambridge University Press, 1952. Cf. also in R. Caverni, *Storia del metodo sperimentale in Italia*, vols. 4-5, Firenze, Civelli, 1891-1900; on fortifications, see A. Cassi Ramelli, *Dalle caverne ai rifugi blindati – Trenta secoli di architettura militare*, Bari, Adda, 1996. For a summary of Tartaglia's studies on projectile trajectories cf. J. Renn, P. Damerow *et alii*, *Hunting the White Elephant: when and how did Galileo discover the laws of fall?*, Preprint 97, Max-Planck-Institut für Wissenschaftsgeschichte, 1998.

The *Nova Scientia*, the first book published by Tartaglia, presents the mathematical elaboration of the topic of cannonball trajectories, i.e. of knowledge which had previously been gained empirically by bombardiers and military engineers: questions connected with military engineering and artillery gained increasing importance in the sixteenth century, given the frequent acts of war in that period and the contemporaneous developments of artillery.
Tartaglia follows the Aristotelian distinction of *natural* and *violent motion*, as well as their supposed incapability of mixture: so, he described the trajectory partitioned in three sections: a rectilinear phase at the beginning of the shot during which the cannonball gains height,[1] then a curvilinear part in form of a circle section in which it starts to fall, and finally again a straight line that concludes its fall. Further, the Brescian mathematician stated the rule that the maximal horizontal distance covered by a projectile is achieved by firing the artillery piece at an elevation of 45 degrees, and that any intermediate distance can be reached by firing at either of two complementary angles.

Arguments related to warfare are approached also in Books I-VI of the *Questioni et inventioni diverse*, all in all nine books, like again the problem of the trajectory of cannonballs, the positioning of armies and fortification. Here, Tartaglia included important modifications to the theories he had exposed in the *Nova scientia*, conceding that a body could possess violent and natural motion at the same time, distancing himself from his earlier view influenced by Aristotelian conceptions. Now, he argued that every part of the cannonball trajectory in reality was curved, which constituted an important step in the analysis of the laws of motion, even if it was only Galileo to furnish a correct and complete mathematical description of that case.
Before the ninth book, dedicated to problems relative to algebra and geometry, Tartaglia included two books discussing two of the mechanical traditions sketched out in the precedent sections: the seventh contains critical reflections on the *Quaestiones Mechanicae*, while the eighth exposes central theorems of Jordanus's mechanics: his critiques against the Aristotelian writing refer to the first two *Quaestiones* which deal with the balance. In fact, he did not completely agree with Aristotle's statement that large balances would be more precise than small ones: according to Tartaglia, this is only true in mathematical abstraction. But as far real balances are concerned, the exact contrary is valid. Regarding the second *Quaestio*, the Brescian mathematician substantially agrees with Aristotle: a balance with rotation point *above* the beam would turn to the horizontal position, if its weight was removed in an inclined position; a balance with rotation point *below* the beam, instead, would remain in the inclined position. Interestingly, he remarks that in the *Quaestiones Mechanicae* there is no treatment of

[1] In reality, Tartaglia was somewhat incoherent concerning the straightness of parts of the trajectory, cf. J. Renn, P. Damerow, *Hunting the White Elephant*, cit.

the third possible case, i.e. when the rotation point lies exactly on the balance beam. Tartaglia (erroneously) claims that the balance would return to the horizontal position in this case, following Jordanus's statement: this is the topic that links the seventh with the eighth book of the *Quesiti et Inventioni diverse*, where Tartaglia presents Jordanus's mechanical theory, in particular his analysis of the isostatic balance.

Therein, Tartaglia substantially exposes a selection of the content of *De Ratione Ponderis*, with some original elements and minor modifications.[1] After the exposition of Jordanus's postulates, he comes to speak of the isostatic balance, in *Quesiti* XXXII and XXXIII. In the former, he exposes the medieval mathematician's considerations about the isostatic balance, including the alleged non-existence of indifferent equilibrium. *Quesito* XXXIII is a crucial proposition, since it counters a not secondary conceptual problematic of the notion *gravitas secundum situm*: the concept does not permit to compare the *positional* weight of two bodies of unequal gravity: was it able to counterbalance a positionally heavier weight on a balance, by adding an extra-weight to the positionally lighter body? This is exactly what Tartaglia has his interlocutor, Ambassador Mendoza, forward, intending to confute the objection subsequently.
He exposes what at first sight substantially resembles the reasoning of the second theorem of Jordanus's *De ratione ponderis*.[2] Nevertheless, there are two relevant argumentative differences introduced by Tartaglia: while the *De Ratione Ponderis* considers *unequal* weights (the lower one is the heavier one), the Brescian mathematician deals the case of two *equal* weights. Further, also Tartaglia's choice of the angles of descent seems more coherent than Jordanus's.

So, Tartaglia's merits in regard of the *Scientia de Ponderibus* are at least two: he made the remarkable propositions of *De Ratione Ponderis* accessible, which were much more developed than the ones of *De Ponderibus* – Apian's edition of 1533 represented, with *De ponderibus*, the only printed treatise of Jordanus until Tartaglia's *Quesiti et Inventioni diverse*, and the latter's posthumous edition of *De Ponderositate* (1565) was chronologically after the *Quesiti e Inventioni diverse*.
Further, the Brescian mathematician emended certain incongruities of Jordanus's theory: interestingly, in *De Ponderositate* the reasoning regarding the isostatic balance is identical to the one exposed in *De Ratione Ponderis*, so Tartaglia's work of 1546 was the only one which contained the aforesaid corrections.
Tartaglia then presented further propositions of Jordanus, like the law of the lever

[1] A novelty, for example, is his introduction of considerations relative to bodies with different *gravità in specie*, which is absent in Jordanus, at least in the first three parts of *De Ratione Ponderis*. For a short overview of Jordanus's mechanics, cf. Part A, III.4.

[2] A detailed analysis of the isostatic balance and the various, different approaches to this problem from Jordanus to Benedetti, are exposed in Part B, chapter I.

(in the latter's version), the propositions on the real balance (cf. *De Ponderibus*, Prop.s X-XIII), and above all the inclined plane with the first correct statement of its law.

Girolamo Cardano[1]

Only a small part of Cardano's (1501-1576) work deals with mechanics, his main interests having been medicine and astrology. His mechanical contributions are mainly included in *De Subtilitate* (1550) – an encyclopaedia of the natural science of that time which had a considerable fortune, with eight editions only in the sixteenth-century (and seven of its French translation) – and in the *Opus novum de proportionibus numerorum, motuum, ponderum, sonorum, aliarumque rerum* (1570).

Parts of Books I and XVII are dedicated to the study of mechanical machines, among them lever, pulley, screw, siphon, furnaces, and devices suggested by Ctsebius and Heron. The single treatments generally do not present geometrical models. At the end of the first book of *De Subtilitate*, Cardano deals with the balance. He takes into consideration two different types of balance, with supports respectively above and below the beam, and states his own (erroneous) theory, differing from Aristotle's, Jordanus's and Tartaglia's, taking into account a curious new magnitude, the *angulus a meta* that would determine the behaviour of the balance.
As far as his studies on motion are concerned, it has been highlighted that Cardano oscillates between elements of the *impetus*-theory on the one hand, and of the Aristotelian one on the other:[2] he favoured the idea that at the beginning of the trajectory, the projectile is moved by the impetus of the firing mechanism, but subsequently accelerated by the movement of the air. Further, he affirmed that perpetual motion was impossible, except in heavenly bodies.

In the *Opus novum de proportionibus*, Cardano turned to problems of mechanics, with the principal aim of applying quantitative methods to the study of physics. Yet, generally, its content seems little coherent, despite of containing some aspects of ingenuity: Cardano appears not to have sought a system of

[1]For further information on Cardano's contribution to mechanics, cf. Drake & Drabkin, *Mechanics in Sixteenth-Century Italy*, Madison The University of Wisconsin Press, 1969. G. Cardano, *De Subtilitate libri I- VII*, ed. by E. Nenci, Milano, Angeli, 2004. Cardano's biography and overviews of his work are exposed in M. Gliozzi, *Cardano, Girolamo*, entry in "Dictionary of Scientific Biography", Ch.C. Gillispie (edit.), New York, Scribner's Sons, 1980; in M. Cantor, *Vorlesungen über Geschichte der Mathematik*, vols.4, vol. II, Leipzig, Teubner, 1880-1908.; and in R. Caverni, *Storia del metodo sperimentale in Italia*, cit.

[2]Cf. M. Gliozzi, *Cardano, Girolamo*, entry in "Dictionary of Scientific Biography", Ch.C. Gillispie (edit.), New York, Scribner's Sons, 1980.

mechanics, but rather to have recorded his (disconnected) reflections at various times.

Aristotelian elements are mixed with unorthodox aspects in Cardano's work: bodies in natural motion would accelerate because of an appetite to approach it *natural place*; on the other side, Cardano adds a third category of motion to the two orthodox ones (*natural* and *violent*): the "*voluntary*" motion, exemplified by circulation of the celestial spheres around the center of the universe: in this category, the body as a whole remains in one place.

Further, there is a treatment of the inclined plane in the *Opus novum de proportionibus*. Differing both from Jordanus's solution and from Pappus's, Cardano offers a "proof" that the effective weight of a body on the inclined plane is proportional to the ratio of the angle of the plane to the right angle. This (erroneous) treatment of the inclined plane is an example for the incongruities of Cardano's theory: in the proof he comments that no appreciable force is required to move a body horizontally, while in other propositions he discusses the force needed to draw or push a body along the horizontal, relating this to the shape of the body and the position of the applied force.

Another field of interest concerns the speed of fall. So, Cardano states that spheres of the same material, falling from the same place through air or water, reach the horizontal plane at the same time. This fact of equal speed seems to have been discussed frequently in the second half of the sixteenth century: it is exposed, *inter alia*, also in Benedetti's work of 1585 (cf. next paragraph), in a work composed by Giuseppe Moletti in the 1570s,[1] in Galileo's *De Motu Antiquiora* and also in Guidobaldo's manuscript *Meditatiunculae*.[2] Regarding the fall in different media, Cardano asserted that the weights of two bodies descending in the same time through the same interval are in the inverse ratio of the squares of the densities.

[1] Cf. Drake & Drabkin, *Mechanics in Sixteenth-Century Italy*, cit.

[2] Cf. Part A, chapter VI.

Giovanni Battista Benedetti[1]

Benedetti's (1530-1590) studies on the motion of bodies constitute important contributions to sixteenth-century mechanics. He approached this topic in various occasions: after the *Resolutio* (1553) and two different versions of the *Demonstratio* in (1554 and 1555), he came back to the topic, again, in the *Diversarum speculationum Liber* (1585). This last work moreover contains the chapter *De Mechanicis* on balance, lever and other mechanical machines, including critiques against Aristotle's *Quaestiones Mechanicae*, as well as against Jordanus's and Tartaglia's treatment of the isostatic balance.

In the *Resolutio* (1553),[2] the first work published by Benedetti, the 23-years-old scholar summarised in a part of the preface – the work was actually dedicated to problems connected with the construction of figures with the compass – his theory *De Motu Graviorum* which was in open contrast with the Aristotelian theory of proportionality between the velocity of fall and the weight of heavy bodies. Instead, Benedetti claims, both as hypothesis and then as theorem, the velocity of a body in a medium to be proportional to his specific weight in the medium (i.e. subtracted its buoyancy). This is proved as consequence of the theorem that homogeneous bodies fall with the same velocity, and by his (unproven) statement that the hypothesis is valid for bodies of equal form and volume, but of different material. This is the result where Benedetti most significantly dissociates himself from Aristotle: all bodies of the same kind and form would fall with the same velocity, independently from their weight.
In the **Demonstratio* (1554), Benedetti approaches the conceptual re-systematisation of the theory published just one year before: in effect, he does not add substantial novelties, but resolves the main argumentative problem of the *Resolutio*, where he starts with the statement of the aforesaid supposition which he

[1]For further information on Benedetti's mechanics, cf. the following studies: biographic studies on the Venetian scholar are G. Bordiga, *Giovanni Battista Benedetti filosofo e matematico veneziano del secolo XVI*, in "Atti dell'Istituto veneto dei scienze lettere ed arti", LXXXV 9.10.2 (1925/26), pp. 585-764; and C. Maccagni, *Contributi alla biobibliografia di Giovanni Battista Benedetti*, in "Physis", IX 3 (1967), pp. 337-364. The texts of the rare editions of 1553, 1554 and 1555 are transcribed in C. Maccagni, *Le speculazioni giovanili* De Motu *di Giovanni Battista Benedetti*, Pisa, Domus Galilaeana, 1967. An analysis of Benedetti's theory on the motion of bodies is contained in E. Giusti,*Gli scritti* De Motu *di G.B. Benedetti*, in "Bollettino di storia delle scienze matematiche", XVII (1), 1997, pp. 51-104. For a description of Guidobaldo's marginal notes of Benedetti's *Diversarum Speculationum Liber*, cf. J. Renn, P. Damerow, *Guidobaldo's Marginal Notes on Benedetti's* Diversarum speculationum, in A. Becchi, D. Bertoloni Meli, E. Gamba, *Guidobaldo del Monte (1545-1607). "Mathematics" e technics from Urbino to Europe*, Proceedings of the conference "400^o Anniversario della morte di Guidobaldo del Monte" Urbino-Mombaroccio June 15th-16th 2007, Berlin, Edition Open Access, 2012.

[2]The notation adopted here follows the one of E. Giusti, *Gli scritti* De Motu *di G.B. Benedetti*, cit., whose analysis will be exposed in the present paragraph.

subsequently demonstrates: the law of motion is not any more stated as hypothesis, but is presented as the conclusion of a demonstrative argumentation.
Shortly after the publication of the **Demonstratio*, Benedetti must have become aware of a decisive weakness of his theory: in his precedent vision of motion, he had taken into account the resistance of the medium only in regard of the specific weight of the body in the medium; any consideration of the form and surface of the body was absent. He tries to insert this aspect in his precedent theory, hastily publishing the ***Demonstratio*, but does not succeed in resolving the fundamental problem: while the resistance of the medium in basis of the buoyancy is proportional to the volume of the body, the resistance acting on the surface is proportional to its area. So, the ***Demonstratio* does not even offer any new attempt to sketch out a global theory of motion, taking into account the changed mechanism in which the medium exercises his resistance; the isochronism of the fall of the homogeneous bodies, one of the cornerstones of the theory in the *Resolutio* and **Demonstratio*, is now stated only for the motion in the void (extended, though, to arbitrary bodies).
In the *Diversarum Speculationum rerum mathematicarum et physicorum Liber* (1585), after thirty years, Benedetti revisits the topic, exposing a new approach based on the principle that the velocity of fall is proportional to the weight of the respective body and inversely proportional to the extrinsic resistance, i.e. to the surface of the body. So, Benedetti's studies had arrived at a position which substantially was not dissimilar to the Aristotelian one: despite of having harshly criticised the theorem according to which the velocity of fall was proportional to the weight and inversely proportional to the resistance of the medium, Benedetti's conclusion is not different in substance: the only differences are that, where Aristotle considered the absolute weight, Benedetti refers to the weight in the medium; and while for the Stagirite the resistance of the medium was proportional to its density, the Venetian mathematician took into consideration only the surface of the body.
Yet, besides the similarities of the results, a substantial difference lies in the approach: while for Aristotle the mathematical treatment was rather marginal compared to the philosophical argumentation, Benedetti considers the geometrical approach the only possible to reach truth. This last aspect is one of the greatest contributions of Benedetti to the studies of the laws of motion, which later were successfully approached by Galileo. In contrast to the latter, Benedetti tried to include both the effects of buoyancy and the extrinsic resistance of the medium in his theory – unfortunately with the result that he did not succeed in thoroughly treating neither the first nor the second.

The *Diversarum Speculationum Liber* is interesting also for its twenty-five propositions on balance, lever, pulley and on several problems of the *Quaes-*

tiones Mechanicae, exposed in the chapter *De Mechanicis* (pp. 141-167).[1]
In the first two propositions, Benedetti treats the angular balance and correctly states the verticals to be the measures of the effective distances between weights and fulcrum. In the third, he presents an interesting (but erroneous) way of how to measure a force which does not act along the perpendicular on balance or lever. After some theorems on the lever, he comes to speak on the isostatic balance in the seventh and eighth proposition, criticising the treatments of Jordanus (and Tartaglia) and ignoring Guidobaldo's, exposed in the *Mechanicorum Liber*. Interestingly, Benedetti exposed a solution completely different from his predecessors, basing himself on the third proposition. Subsequently to Proposition VIII, the Venetian scholar attacked other theorems of the *Scientia de Ponderibus* exposed by Tartaglia and Jordanus.
After a proposition on the Roman balance (prop. IX), Theorems X-XXV then again testify Benedetti's critical attitude towards Aristotle, treating and contradicting several statements of the *Quaestiones Mechanicae*:[2] in this context, he exposes his own theory of pulley and wedge. The second part of the book, in which Benedetti approaches single arguments in form of letters, deals, *inter alia*, with Archimedes's *Equilibrium of Planes*.[3]

[1]Most interesting is the exemplar of the work, recently acquired by the Max-Planck-Instutut für Wissenschaftsgeschichte: it contains marginal notes made by Guidobaldo himself, cf. http://echo.mpiwg-berlin.mpg.de/content/historymechanics/mpiwg. See also J. Renn, P. Damerow, *Guidobaldo's Marginal Notes on Benedetti's* Diversarum speculationum, cit.

[2]So, Benedetti attacks Aristotle's solution of the *Quaestiones* I, II, III, VI, VIII, IX, X, XII, XIII, XIV, XVII, XXIV, XXX and XXXV.

[3]The respective letter is addressed to a certain Vincenzo Mercato, see *Diversarum Speculationum Liber*, pp. 380-396.

Chapter IV

The *Mechanicorum Liber*

The Mechanicorum Liber *is Guidobaldo's principal writing on mechanics. It revisits a topic going back to Heron and Pappus, i.e. the description of the Simple Machines lever, pulley, winch, wedge and screw. Guidobaldo succeeded in establishing a mathematical model of the machines, reducing their operation mode to the lever and furnishing geometrical proportions of the involved forces and weights. Further, he made first, important steps in the direction of the identification of a* compensation principle *for mechanical machines. Another relevant theoretical-conceptual aspect is Guidobaldo's prove of the existence of indifferent equilibrium for a particular kind of balances.*
The actual description of the writing in IV.2, with an overview of the content and the analysis of relevant aspects and problems like the fourth proposition De Libra, *the convergence and parallelism of the lines of action and the distinction of* potentia sustinens *and* potentia movens, *is preceded by section IV.1 dedicated to the contextualisation of the treatise: particular attention is focused on two traits of Guidobaldo's work which seem particularly relevant: his activities as architect-engineer and technician (cf. IV.1.1), as well as his interaction with the world of the engineers (cf. IV.1.2).*

IV.1 Contextualisation

Before we attend to the analysis of the *Mechanicorum Liber*, it is convenient to dwell a little on Guidobaldo's biographical situation in which he composed his first and principal work on mechanics. This can help to understand the context of its genesis and to comprehend certain aspects of the writing.

Guidobaldo was the first born son of Ranieri dal Monte, one of the most influential characters of the Duchy of Urbino. From early childhood, he was part of the young Prince's court and deeply influenced by the predominating humanistic climate, with main accents on philosophy and mathematics. As his father and

many other members of his family, Guidobaldo prepared to undertake a military career. Five years after a military campaign in Hungary in 1566, he accompanied Prince Francesco Maria della Rovere to the naval battle of Lepanto and would have fought on his side, if a serious form of sciatica had not retained him at Messina. This was a turning point of his life as he had to abandon his plan to become a military captain.
At this time he must have decided to dedicate his life to the mathematical studies, begun several years before, first at the University of Padua and then with Federico Commandino. It was in this context that he came in contact with Pappus's *Collectiones Mathematicae*, in those times only in manuscript form: both his interlocutor at Padua Gian Vincenzo Pinelli as well as Commandino owned copies of the work whose eighth book contained a treatment of the five Simple Machines.
The contact with this book constituted the stimulus for Guidobaldo to write the *Mechanicorum Liber*: his intent was to lay bare the geometrical model underlying under the machines – absent in Pappus – in order to explain their operation mode. The works on the treatise seem to have begun already during Commandino's lifetime, probably parallel to his master's works on the translation of the Pappian original.[1] The work was published in 1577, when Guidobaldo was 32 years.

The topic of mechanical machines must have fascinated Guidobaldo: as the following subsection will evidence, Guidobaldo was very active in the capacity of engineer and architect, so he was in direct contact with mechanical machines and consequently concerned with their construction and use. Also during Guidobaldo's military experiences, the employment of machinery was usual. In this regard it is convenient to keep in mind that Guidobaldo possessed a book containing drawings of various mechanical machines made by Francesco di Giorgio Martini.[2] This little manuscript notebook (15,6 cm x 11,2 cm; 37 folios) shows the connection between the Simple Machines, treated by Guidobaldo in the *Mechanicorum Liber*, and the more complex machines, composed by them, employed in the everyday-praxis of an architect-engineer.
Moreover, the Marchigian mathematician dedicated himself to the invention of scientific instruments or to the construction of sundials, which documents his interest in the "practical" aspects of his occupation with mathematics. One of the most relevant aspects of the *Mechanicorum Liber* is connected with this trait of Guidobaldo: the exposition of the isostatic balance with its indifferent equilibrium.
Further, as IV.1.2 will document, Guidobaldo was in brisk contact with the world

[1]Documents recently found at the Bibliothèque Nationale de France in Paris suggest that the works on the *Mechanicorum Liber* had already begun when Commandino was still living and that Guidobaldo received advice and corrections by his master: cf. Appendix I, I.2.1.

[2]This manuscript notebook is conserved at BNMV Lat. VIII, 87 (3048) and is entitled "Guidi Ubaldi ex Marchinibus Montis Organa mechanica".

of the engineers and technicians. The interaction with the exponents of this professional stratum influenced also Guidobaldo's scientific activity and had real repercussions on his work.
Besides these factors, also Commandino's teaching had a decisive role for the genesis of the latter's principal mechanical work. It equipped Guidobaldo with the mathematical skills to approach the enterprise of describing the geometrical structures underlying under the function of the Simple Machines. Moreover, Commandino's orientation towards Greek mathematics – and the general humanistic climate of the ducal court – surely contributed to Guidobaldo's to approach this Pappian/Heronian topic of the Simple Machines.
These factors seem to be decisive to approach the *Mechanicorum Liber*.

In the present section, we will expose documents testifying that Guidobaldo received stimuli for his scientific work by his activities as architect-engineer or by his interaction with other members of his "technical" circle. Yet, this aspect obviously is not sufficient to explain Guidobaldo's mechanical work, in particular the *Mechanicorum Liber*. These stimuli constituted only a pre-stage for a *scientific* occupation with mechanics: in fact, if it is true that, in the *Mechanicorum Liber*, he programmatically proclaimed that "mechanics can no longer be called mechanics if it is separated from machines",[1] so it is similarly true that he strictly refused a non-scientific, too practical-orientated approach to mechanics. In effect, in a letter to F. Pigafetta,[2] he contraposes two models of mechanics, respectively symbolised by Archimedes on the one hand and Vitruvius on the other:

> Credo bene che egli <Archimede> si sdegnasse di scrivere come fece Vitruvio, il quale insegna come si debbono accomodar le travi e legar le machine per tirar li pesi, essendo cosa il trattarne di questo modo molto vile; ma scriverne scientificamente siccome egli ha fatto in questi libri che ho citati di sopra, è cosa molto bella et da non sprezzar, et da non tener per bassa. Et quest'è quant'io Gli posso dir succintamente secondo la mia opinione sopra Archimede. (...)

IV.1.1 Guidobaldo as engineer-architect and inventor of scientific instruments

In the present subsection, we expose an overview of Guidobaldo's works in the capacity of engineer-architect and technician. Even if they partly refer to a period after the publication of the *Mechanicorum Liber*, the information is anyway useful both to have an idea about Guidobaldo's interests and activities in the 1570s

[1] *Mechanicorum Liber*, p. viii (not numbered): "Neque enim amplius mechanica, si a machinis abstrahatur et seiungatur, mechanica potest appellari."

[2] Cf. BAM, D34 inf, fol. 121r; April 29th 1581.

about which we have very few documentation, as well as to comprehend his multi-layered intellectual personality.

Guidobaldo's activity as military engineer

Last years' researches of several scholars have brought to light interesting material on Guidobaldo in the capacity of civil architect and military engineer. They permit us a closer insight in Guidobaldo's multi-layered intellectual personality.

From early childhood, Guidobaldo was familiar the milieu of engineers and architects, as his father active in this capacity: we know that he wrote a treatise on fortification;[1] further, Ranieri seems to have been the architect of Santa Maria degli Angeli at Pesaro.[2]
Also Guidobaldo soon imitated his father: as far as his activity as military engineer is concerned, its maybe[3] earliest testimony is contained in a letter of Guidobaldo to Pigafetta of December 31st 1580.[4] The latter had asked to have Guidobaldo's maps of the fortifications of Corfu, whereupon the Marchigian mathematician reacted with reservation: in fact, he called his drawings a *bagatelle*, only made to reluctantly satisfy the request of a friend.[5] The following letter reveals that Guidobaldo's critical judgement of his maps was due to modesty:[6] in effect, there seems to have made part a whole expertise, by military men who knew Guidobaldo's abilities.[7] He had not visited the fortification *in loco*, but rendered his expert report on the basis of the existing map of it.

Famous is Guidobaldo's service towards the Grand Duke of Tuscany as *Visitatore* of the fortifications.[8] He was commissioned with this task in 1588, but it is unclear if he started his inspections in the same year. F. Menchetti's recent studies have shown that he surely was in Tuscany in summer 1589,[9] inspecting the fortifications at Pisa, Leghorn, San Piero a Sieve and Terra del Sole.

[1] For further information about Guidobaldo's father Ranieri dal Monte, cf. Appendix I, I.2.

[2] Cf. Appendix I, I.4.3.

[3] Unfortunately, the letter from Girolamo Arduini to the Duke of Urbino, BOP, ms 434, fols. 15r-18r, exposed below, is not dated; cf. footnote 5 on page 110.

[4] Cf. BAM, R121 sup, fols. 23r-24r. See Appendix I, I.8.1.

[5] Cf. BAM, R121 sup, fols. 23r-24r: "e perché in una Sua dice, che io ho fatto non so che sopra la fortezza di Corfù, Gli dico che è vero, ma che è una bagattella, e non è cosa da esser veduta in modo nessuno, perché quel poco che io dissi, lo feci per obedir un amico."

[6] Cf. BAM D34inf, fols. 103r-104v. See Appendix I, I.8.1.

[7] Cf. BAM D34inf, fols. 103r-104v: "Li mando una copia del mio discorso intorno alla Fortezza di Corfù la quale è precisa come quella ch'io mandai al Capitano Riccio a inquisitione del S.r Paolo <Orsino>."

[8] A detailed exposition of the documents in regard is exposed in Appendix I, I.4.3.

[9] Cf. F. Menchetti, *Guidobaldo del Monte nel Granducato di Toscana e la scuola roveresca di architettura militare*, in *Guidobaldo del Monte (1545-1607). "Mathematics" e technics from Urbino to Europe*, cit.

Then in January 1590 he turned (at least?) to Leghorn:[1] his arrival two days after the laying of the foundation stone gives us an idea about his fundamental role in the planning and of the *Fortezza Nuova*, and explains at the same time why he has not ever been considered as one of its architects.[2]

Our attempts to unify and publish Guidobaldo's correspondence have brought to light a letter revealing that Guidobaldo's service to the Grand Duke of Tuscany was not an isolated case:[3] Guidobaldo's services in the capacity of military engineer were employed also by the Duke of Mantua: the former, in 1589, had corrected the plot of the fortress Casale Monferrato. It is not clear, though, if Guidobaldo had been *in loco* and if this service was limited to this occasion.
Another document gives ulterior hints that Guidobaldo was frequently active as military engineer:[4] a letter (without date) from the ducal architect Girolamo Arduini to the Duke of Urbino explicitly names Guidobaldo's involvement in the design of a not explicitly named fortification of the Duchy of Urbino.[5]
The fact that Arduini dedicated his treatise on fortification to Guidobaldo might be another confirm of a close collaboration between the ducal architect and the Marchigian mathematician.[6]

Occupation with civil architecture

Guidobaldo's occupation with civil architecture seems to have been decisively influenced by his close relation to Duke Francesco Maria II: various documents show Guidobaldo active as architect, consultant or supervisor of ducal construction projects. An example is the restructuring of the park of the ducal villa Miralfiore which posed some hydraulic problems: both in 1583 and 1587, we see

[1]Cf. ASF, Diari di Etichetta di Guardaroba 1, published by M. Biagioli, *The social status of Italian mathematicians 1450-1600*, in "History of Science", XXVII (1989), pp. 41-95.

[2]As architects are listed B. Buontalenti, V. Bonanni and G. de' Medici.

[3]Cf. ASM, busta 1117, fol. 496r. See Appendix I, I.4.3.

[4]Cf. BOP, ms 434, fols. 15r-18r. See Appendix I, I.8.1. This document has independently discovered also by F. Menchetti, cf. *Guidobaldo del Monte nel Granducato di Toscana e la scuola roveresca di architettura militare*, in *Guidobaldo del Monte (1545-1607). "Mathematics" e technics from Urbino to Europe*, cit..

[5]Cf. BOP, ms 434, fols. 15r-18r: "quando non si possano cavare o ben poccho, come ne' sassi vivi, acque, paludi o che molto vicina ella sia al piano della campagna, come è questo nostro luogo del quale ora ci occorre di ragionare, il quale al mio parere doveria essere solo sì profondo come si ritrova ora il piano del fosso vecchio acciò che l'acqua non abbia scaturendo a causarci male aere, et largo al parere e disegno del Sig.r Guid'Ubaldo, et averse oltre la capenza del fosso una giunta et altezza di sei in sette piedi che in tutto [scendesse] all'altezza di diece in undici piedi (...)."

[6]Cf. BOP, ms 966 (D. Bonamini's "Cronica della città di Pesaro"), pp. 134/135: "Fu costui <Girolamo Arduini> un eccellente militare e bravo matematico, ed autore d'un manoscritto intitolato *Modo di piantare e fortificare una città* di pagine 24 in quarto. Tale sua opera fu da lui dedicata al Marchese Guid'Ubaldo del Monte." For further information on G. Arduini, cf. Appendix II, chapter II, "Girolamo Arduini".

Guidobaldo active in several on-site inspections with Arduini and the "construction manager" mastro Lazzaro, in the attempt to improve the water supply for the fountain and the fish pond in the park.[1]
In this context, in 1587, Guidobaldo was also appointed as the responsible for the construction works of the new fountain on the main place of Pesaro, in front of the ducal palace by the intervention of the Duke in the Council of Pesaro.[2]
There are good reasons to suppose that Guidobaldo was involved also in works at the port of Pesaro, which was object of frequent maintenance and modification operations. So, in a letter to the ducal secretary Giulio Veterani, the Marchigian mathematician wrote:

> This letter of mine is supposed to inform you that the works at the port have been begun. (..)[3]

Finally, also Guidobaldo's involvement in the festivities in the occasion of Pope Clement VIII's passage at Pesaro in 1598, seem to have been conditioned by the Duke: he was the responsible for the edification of two triumphal arches at Pesaro, as sign of the city's submission to the authority of the Pope who was the overlord of the Duke of Urbino.

Other projects realised by Guidobaldo in the capacity of architect do not seem to have been in direct relation with the Duke. So, as recently found documents testify, he was architect of the church St. Maria degli Angeli at Pesaro.[4] Even more interestingly, In the document that characterises Guidobaldo as architect,[5] he himself puts on record that

> the most Illustrious Sir Guidobaldo has been occupied in many other constructions (...)[6]

[1] Ample documentary material in regard is exposed in Appendix I, I.3.2 and I.4.1.

[2] Cf. ASCP (BOP), II C I, fols. 67v-69r: "Proponesse il S.r Confaloniere et sentitosi varie opinioni de' SS.ri cittadini fu poi concluso viva voce che li già eletti sopra la fonte insieme coll'Ill.mo S.r Guidobaldo de' Marchesi voluto anche da S.A. debano seguitare l'opera della fonte colla medesima autorità ch'è stata loro data nell'altro partito et come nella lettera ducale oggi letta in consiglio."

[3] Cf. BOP, ms 426, fol. 157r; see Appendix I, I.4.1.

[4] Cf. Appendix I, I.4.3.

[5] This document is BOP, ms 1841, which constitutes the records of a lawsuit in 1589: the church had crash down and the Camaldolese order charged the masons to have caused this with their bad work. Guidobaldo depones that the cause of the crash was to be attributed to the pre-existing walls on which the church was founded, since they had been taking up water.

[6] BOP, ms 1841, fols. 242v-243r: "(...) quando li Molto Reverendi Padri dell'ordine camaldolese fecero risoluzione di voler erigere in Pesaro il Convento et Chiesa da nominarsi Santa Maria delli Angioli presero pur Protettore et [loro] [Fautore] l'Illustrissimo Signor Raniero <dal Monte> suo Padre di felice ricordatione et esso Illustrissimo Signor Guidobaldo suo figliolo per esser loro amorevole della religione sudetta et anco per esser esso Illustrissimo Signor Guidobaldo intervenuto in molt'altre fabriche et acciò fossero [asistenti] // [fol. 243r] all'[aviso]

Another construction work built under Guidobaldo's direction was the city residence of the Mamiani family.[1] His involvement in this prestige project – the Mamiani had displaced the dal Monte as the most influential family at court, in those years – is significant for the reputation he apparently enjoyed in the capacity of architect.

Evident reflections on practical-technical problems, met by Guidobaldo during his activities as architect-engineer, are contained in his notebook *Meditatiunculae*.[2] These include notes on how to calculate the heights of towers, how to calibrate defective cannons, on practical (dis-)advantages of certain kinds of mechanical machines, and on the inclination of roofs, or of the water intake of mills.

Invention of scientific instruments and occupation with technical devices

Guidobaldo by no means was a scholar who was exclusively interested in theoretical questions. On the contrary, the extant sources show us his interest in technical devices and testify that he himself invented several scientific instruments. So, Muzio Oddi tells us in his *Fabrica et Uso del Compasso polimetrico* that his teacher Guidobaldo had developed, on the basis of Commandino's predecessor model, a proportional compass.[3] He puts this event in relation with Guidobaldo's frequent collaboration with Simone Baroccio, brother of the famous painter Federico and himself a master craftsman. This period has plausibly to be collocated at the early 1570s:[4] in effect, again Oddi tells us that his teacher had invented a new type of sundial, working with refracted rays of light, and had it fabricate in 1572 again by Barocci.[5]

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et sollecitudine che detta fabrica et che esso Illustrissimo Signor Guidobaldo desse il designo di quella come diede et si essequisse il tutto secondo il suo parere."

[1]We know this thanks to the researches of D. Trebbi, exposed in *Palazzo Gradari, già palazzo Mamiani della Rovere*, Senigallia, Futura Officine Grafiche, 2004.

[2]For further information, cf. chapter VI.

[3]Cf. M. Oddi, *Fabrica et Uso del Compasso polimetrico*, cit.; pp. 3-4 of the Proemio: "L'Illustrissimo Signore Guidobaldo de' Marchesi del Monte, che in quei tempi si tratteneva in Urbino per conferire i suoi studii con il Commandino, et spesso era alla casa dove lavorava il <Simone> Baroccio, avendo più volte veduto il sopradetto istrumento <il compasso di Commandino>, et considerando con la felicità del suo ingegno che si poteva sodisfare al medesimo desiderio con assai minor fatica e spesa, ne fece dall'istesso fare uno con le gambe piane a guisa di due regoli più larghi che grossi (...)." In this context, cf. E. Gamba, *Documenti di Muzio Oddi per la storia del compasso di riduzione e di proporzione*, in "Physis", XXXI (1994), pp. 799-809.

[4]This is confirmed by Oddi's reference to Guidobaldo's contemporaneous participation in Commandino's mathematical lessons.

[5]M. Oddi, *De gli Horologi Solari*, cit., pp. 99-100: "Ben so de' moderni, che l'anno 1572 l'Illustrissimo Signor Guidobaldo de' Marchesi del Monte ne fece fare uno da Simone Baroccio, eccellente artefice, in una mezza sfera d'ottone, e hollo avuto nelle mani molto tempo (...)."

Also the *Meditatiunculae* reflect this trait of Guidobaldo: page 112 shows two instruments for drawing parallel lines. And this was no isolated case, as we learn from a letter of Orazio dal Monte to Galileo in 1610:[1] the former wanted to publish a short treatise with the descriptions of "various instruments invented by my father".

Guidobaldo, besides the invention of new instruments, generally was dealing with technical devices: so, he was a kind of supervisor of the fabrication of mechanical clocks in the Duchy of Urbino.[2] These were objects of great value, fabricated by master clockmakers at Urbino and Pesaro and then offered as presents to Popes, Cardinals and Dukes by Francesco Maria II.[3] Several years of the year 1583 show Guidobaldo involved in the control of these clocks;[4] and in effect, in this context, the Marchigian mathematician had controlled the clock and intended to have the clock modified.[5]

This activity is closely related to the existence of workshops of precision instruments in the Duchy of Urbino.[6] The importance of this fact for Guidobaldo's activity should not be underestimated. In fact, in the year 1580 Guidobaldo exchanges several letters with G. Contarini and F. Pigafetta about the treatment of the Simple Machines in the *Mechanicorum Liber*: the latters did not succeed in reproducing the relations between weights and forces as predicted geometrically by Guidobaldo. So the Marchigian mathematician explained to his interlocutor Contarini:[7]

[1] Cf. BNCF, mss Gal 88, fol. 136r; see Appendix I, I.7.3: "Io mi ritrovo in essere alcune opere di mio Padre <Guidobaldo> b.m., che le vorrei dar fuori (...) et le opere son curiose: *la Cochlea che inalza l'aqua*, divisa in quattro libri, (...) et la fabrica di alcuni istromenti ritrovati da lui; delle quali tutte cose vi sono le figure intagliate." The letter is published in G. Galilei, *Opere*, Vol. X.

[2] A collection of interesting documents in regard is exposed in Appendix I, I.3.3.

[3] We intend to publish in the near future an article about the fabrication of clocks in the Duchy of Urbino, together with Enrico Gamba. In our opinion, this is an exemplary case of the close relations of the technical, scientific and diplomatic world in the sixteenth century.

[4] For example, G. Arduini wrote to Count de' Tommasi (cf. BOP, ms 434, fol. 57r/v; 1st September 1583): "(...) ho mandato a dire a mastro Pietro orologiero, che dia l'orologio della tartaruca al S.r Guid'Ubaldo, acciò veda se è giusto; il mastro me ha detto che subbito lo portarebbeno (...)."

[5] Cf. BOP, ms 426, fol. 155r/v: "Ho poi tenuto la toretta da che Vostra Signoria mi scrisse l'altra Sua, ma non Glene voglio dir altro per adesso perché come torna mastro Pietro <Griffi> gli farò accomodar alcune cosette e poi scriverò in che modo vadano le ore."

[6] Cf. E. Gamba, V. Montebelli, *Le Scienze a Urbino nel tardo Rinascimento*, cit., pp. 18-20.

[7] Cf. BNMV, It. IV, 63 = Ven. 259; October 9th 1580; published in A. Favaro, *Due lettere inedite di Guidobaldo del Monte a Giacomo Contarini*, in "Atti del Reale Istituto Veneto di scienze, lettere ed arti", LIX 2 (1899-1900), pp. 307-310. The complete Italian transcription is exposed in Appendix I, I.8.2.

> You should know that before I have written anything on the *Mechanicorum Liber*, I never wanted (in order not to make errors) to determine anything, as irrelevant as it could have been, if first I had not seen that the experiment (*esperienza*) exactly agreed with the demonstration; and of very little thing I have made its experiment. (...)
> Anyway, it is most sure that practice and theory always agree and do not differ from each other. And I say you even more: the demonstrations have taught me very much about how to make the experiments, regarding which many things have to be considered: firstly, the instruments should be small rather than big; as for example the pullets with its wheels, if possible they should be made out of brass with very thin, iron axes; and the wheels should be well turned so that they do not waggle round the axes; but if possible, it would be very good if they turned around with just a puff.
> In fact, the big pulleys which are able to lift heavy weights, are not that good to distinguish details, as the balances clearly show: in order to distinguish every little details, one has to use those small ones for weighing coins, and not those big ones with which large objects like meat or similar things are weighed, even if they are precise.[1]

Two aspects of this passage seem to merit an emphasis: firstly, the close relation between Guidobaldo's geometrical work on the one hand and the "experiences" with his devices on the other ("la dimostratione mi ha insegnato assai come si hanno da far l'esperienze"; "prima che io abbia scritto cosa alcuna (...) ho voluto determinar cosa alcuna (...) se prima io non vedevo con effetto che la esperienza si confrontasse apunto con la demostratione"). Secondly, the instruments considered by Guidobaldo were not the everyday devices used at the marketplaces (balances) or at building sites (pulleys): in fact, Guidobaldo speaks of special instruments, of small dimensions, made out of brass with "very thin", iron axes to reduce friction to a minimum, so that a blow would suffice to make them turn around.

[1] "La deve sapere che prima che io abbia scritto cosa alcuna sopra le *Mechaniche*, mai (per non far errore) ho voluto determinar cosa alcuna per minima che ella sia, se prima io non vedevo con effetto che la esperienza si confrontasse apunto con la demostratione, e di ogni minima cosa ne ho fatto la sua esperienza. (...)
In somma questa è cosa sicurissima che la pratica con la theorica vanno sempre insieme, né si discostano punto l'una dall'altra. Et di più Le dico che la dimostratione mi ha insegnato assai come si hanno da far l'esperienze, sopra le quali per chiarirsi bene bisogna considerar molte cose: primo che gli instrumenti siano piccoli più presto che grandi; come per essempio le taglie con le sue girelle, che se fusse possibile di farle di ottone con li sui assi di ferro sottili sottili; et che le girelle siano benissimo tornite, le quali non balassero attorn'agli assi, ma però che girassero con un soffio se fosse possibile, questo sarebbe benissimo.
Perché le taglie grandi, che sono atte a levar gran pesi, non sono così buone a chiarirsi delle minutezze, sì come si mostra con essempio chiaro nelle bilancie che, per chiarirsi d'ogni minutia, bisogna tuor quelle piccoline da pesar li scudi, et non quelle di legno grande, che si pesano cose grosse come carne et simili, se ben tutte sono giuste."

A special – and most relevant – case of Guidobaldo's mechanical precision instruments is the isostatic balance, i.e. a balance whose rotation point lies exactly on its beam. In the fourth proposition of the *Mechanicorum Liber* he had demonstrated that the equilibrium manifesting on this balance is indifferent. As we will show in Part B, chapter I, this aspect constitutes one of the central elements of Guidobaldo's mechanics. So, the Marchigian mathematician told to Contarini in the same letter:

> I have constructed a balance which most truly shows me that, if it has the rotation point in its middle, it stays still where it is left in any position where it has been moved; as the fourth proposition *De Libra* in my *Mechanicorum Liber* states. This troubles many scholars that were not able to fabricate it physically.[1]

These isostatic balances were extremely difficult to fabricate. In effect, as Part B, chapter I will evidence, Guidobaldo sent exemplars of it to various interlocutors as they apparently were not able to build them.

IV.1.2 The "engineers' circle" around Guidobaldo

As chapter II has evidenced, Guidobaldo was the centre of a circle composed by scholars interested in mathematics and mechanics. An analysis of the sources suggests the existence of two somewhat distinct groups amongst his interlocutors: one more interested in mathematics and philosophy,[2] and the other rather in applied mathematics, like mechanics or architecture. The present subsection is dedicated to the latter group, which we could conveniently call the «engineers' circle», as we will see in a while. While subsection IV.1.1 has highlighted Guidobaldo's activity as engineer-architect and the implication of a close interaction with other engineers, architects and technicians – members of what C. Maccagni has called the *strato culturale intermedio*, i.e. the intermediate cultural stratum.[3] They generally did not belong to nobility (in difference to the members of Guidobaldo's "philosophical" circle, cf. V.1.2), but had nevertheless enjoyed a sound mathematical education. In fact, Guidobaldo's correspondence and other sources prove his intensive collaboration with characters like the ducal architect Girolamo Arduini, with the famous military engineers Francesco Paciotti and Giulio da Thiene, construction site supervisors as "mastro Lazzaro" or clockmakers like Pietro Griffi.
Besides these collaborations, Guidobaldo's contacts to the intermediate cultural

[1] "Dove ho anco fatto una libra la quale mi mostra verissimamente che avendo il centro nel mezzo di essa, mossa la libra dove si vuole, sta ferma dove si lascia, come dice la quarta proposizione *De Libra* nel mio libro delle *Mechaniche*, che è cosa che dà fastidio a molti che non l'hanno saputa far materialmente."

[2] For further information in regard, cf. Part A, V.1.2.

[3] Cf. in regard note 3 on page 84.

stratum included another activity: as the present subsection will show, the Marchigian mathematician instructed future architect-engineers. Further, in the second part of the subsection, documents are exposed evidencing that this contact and interaction had concrete effects also on Guidobaldo's *scientific* work: in various writings we can track down the traces of reflections on stimuli coming from his contact with his environment.

The extant sources reveal that Guidobaldo was active as instructor for future architect-engineers, technicians and military men.[1] We explicitly know three disciples of Guidobaldo, Niccolò Sabbatini (architect and author of *Pratica di fabricar Scene e Machine ne' Teatri*[2]), Francesco Guerrini (architect) and Gian Giacomo Leonardi (military engineer):
In fact, Sabbatini himself claimed in his work on theatrical machines to have been "a good disciple" of the "Illustrious Guidobaldo dei Marchesi del Monte".[3] Sebastiano Macci (1558-16??), a local historian, specifies the subjects of the instruction, reporting the wording of Sabbatini's epitaph: the latter had

> excellently learned the doctrine of both architectures under Guidobaldo dei Marchesi del Monte.[4]

As far as Guerrini is concerned, the historian Domenico Bonamini reports in his *Abecedario degli architetti pesaresi*:

> Sir Francesco Guerrini was a disciple of the most famous Sir Guidobaldo dal Monte in mathematics and architecture.[5]

Guerrini's connection with Guidobaldo is testified also by the Council Records of Monte Baroccio (the latter's feud): he was responsible for the maintenance

[1] This fact is interesting also in the light of Commandino's "School of Urbino": Guidobaldo did not continue his master's school, but had his own one, with quite different characteristics. An article about this topic is forthcoming.

[2] N. Sabbatini, *Pratica di fabricar Scene e Machine ne' Teatri*, Ravenna, Paoli, 1638.

[3] In *Pratica di fabricar Scene e Machine ne' Teatri*, p. 11, he refers to the sixth book of his master's *Perspectivae Libri sex* for a theoretical study of the subject: "Se brami nondimeno vedere la più fina teorica di questa pratica, ricorri all'Archimede d'Italia, e leggi il sesto libro della *Prospettiva* dell'Illustrissimo Sig. Guidobaldo dei Marchesi del Monte, di cui si gloria l'autore l'essere stato buon discepolo."

[4] Cf. BOP, ms 382 fol. 281r: "Hic enim requiescit // Nicolaus ille // qui utriusque architecturae praecepta optime [ediscit] // Sub Guidone Ubaldo e Marchinibus Montis Italico nostri saeculi Archimede //Alios bene architectam docuit. // (...) // fere octuagentius obiit // VIII Kal. Januarii MDCLIV".

[5] "Scrisse Pier Francesco Macci nella Relazione dell'apparati per le nozze della principessa Claudia, fol. 20, che il Signor Francesco Guerrini fu allievo nelle matematiche ed in architettura del famosissimo Signore Guidubaldo del Monte. Giovi tale notizia per indagarne delle ulteriori circa questo degno sogetto, che sospettasi con tutto il fondamento essere stato l'architetto delle chiesa di Sant'Ubaldo, come da vari pagamenti a lui fatti dal nostro pubblico per tale effetti segnati nel *Libro mastro 1615, cc.419-567* si può sicuramente dedurre."

of the clock of the municipal building to Guidobaldo's lifetime and later the the architect of Communal Tower.[1]

Giovan Giacomo Leonardi (junior), grandson of the famous homonymous diplomat, wrote in a description of his professional experiences to have gained the competences to draw

> the designs of forts, bulwarks, terrains and plans of strongholds <thanks to the formation in> mathematics and fortifications under Sir Guido Ubaldo de' Marchesi del Monte, Count Giulio Thiene and others.[2]

Now, were these three isolated cases? Or were they inserted in a broader context of a systematic education of engineer-architects? Well, there are plausible reasons to believe that this instruction was wanted by the Duke:
First of all, the teaching of mechanics was apparently not connected with Guidobaldo personally: the existence of such instructions also after his death is testified by Guerrini's letter to Clavius of June 24th 1607: "After the death of the Most Illustrious Guido dal Monte, may God rest his soul, several gentlemen of the city of Pesaro have asked me to show them the practice of *Le Mechaniche* of this Sir, as I do".[3]
Then, the Duke seems to have been involved in the control of the formation of the engineer-architects, as we come to know in case of Oddi. The latter wrote in the occasion of the death of Duke Francesco Maria II della Rovere: "Anyway, no harm that I have received could make me forget the great debt that I shall always owe him, for bringing me up in his household, giving me the opportunity to learn, and embellishing me by honouring me with the title of architect".[4]

[1]For the maintenance of the clock, cf. ACM, Libri del Consiglio, 1600-1622, fol. 97r; fol. 106r; fol. 111r; for the construction of the Communal Tower, cf. G. Allegretti, *Monte Baroccio 1513-1799*, cit., pp. 116-17. Further information is exposed in Appendix II, chapter II, "Francesco Guerrini".

[2]This information is given in E. Concina, *La macchina territoriale. La progettazione della difesa nel Cinquecento veneto*, Bari, Laterza, 1983, p. 80: «La capacità di tracciare "disegni de' forti, baloardi, siti et piante di fortezze" gli risulta <a Giovan Giacopo Leonardi> – c'informa il suo stato di servizio – dall'educazione alle "matematiche et forificationi sotto la disciplina del Signor Guido Ubaldo de' Marchesi del Monte, conte Giulio Tiene et altri.»Concina refers, on p. 216, to BNMV, mss P.D.C. 951 "*Milizia navale e terrestre*", n.19: *Servizi militari del Co. Cap.o Gio. Giacomo Leonardi da Pesaro.*

[3]Cf. APUG 529, fols. 112r-113v. This letter is entirely exposed in II.3 and published in E. Gamba, V. Montebelli, *Le Scienze a Urbino nel tardo Rinascimento*, cit. and in U. Baldini, P.D. Napolitani, Christoph Clavius. Corrispondenza, cit.

[4]Cf. BOP, ms 431, fol. 202r/v (June 10th 1631): "Molto Ill.re Sig.r mio oss.mo. La morte del Sig.r Duca mi è doluta molto purché questo che mi sarei mai imaginato per le conseguerize che me sucedevano, et se bene mentre è stato vivo m'ha trattato tanto male; non ha potuto nondimeno nessun danno, ch n'abbia riceuto, fattomi scordare l'obligo grande che li averò sempre che m'abbia alevato in casa sua, datomi occasione d'imparare, et [scolonatomi] con onorarmi del titolo d'architetto." The English translation is contained in A. Marr, *Between*

The Duke obviously was interested in the availability of well-instructed, competent engineer-architects for the numerous large-scale construction works in the Duchy, like ducal villas, fountains or fortifications. Especially the last aspect is inserted in a precise historical context: Urbino, for generations, had generated and hosted outstanding military architects like Francesco di Giorgio Martini, Francesco Maria della Rovere, Girolamo Genga, Gian Giacomo Leonardi, Francesco Paciotti and so on. This fact was also due to instruction. As the Dukes of Urbino lived on warfare and on their services to other sovereigns, concerning also fortification, the availability of expert military engineers and architects was an important factor for the state. So, a stimulation of the formation of engineers by the Duke, by organising certain forms of teachings, seems throughout probable.

A kind of mathematical formation not only for future architects and engineers, but also to master technicians does not seem to have been unusual in the Duchy of Urbino: so Simone Baroccio, the famous head of an outstanding workshop of precision instruments (compasses, sun dials, balances, etc.), is said to have attended Commandino's lectures on mathematics.[1] A passage in the introduction of Baldi's *Automata* confirms this fact of master-technicians' participations in mathematical instruction.[2] Also the instruction of the clockmakers was certainly in the Duke's interest: he hosted them and their workshops in a part of the ducal palace of Pesaro and made them fabricate mechanical clocks that he used for political-diplomatic uses, as a present to various Popes, Dukes and Cardinals.[3]

The involvement of Count Thiene, as testified by G.G. Leonardi's description, might be another hint that the teaching was organised by the Duke: the former was involved in the mathematical education in more than one case – for example

Raphael and Galileo: Mutio Oddi and the Mathematical Culture of Late Renaissance Italy, Chicago, University of Chicago Press, 2011; p. 34.

[1]Cf. P. Bellori, *Le vite de' pittori, scultori et architetti moderni*, Roma, 1672, p. 175 (entry on Federico Barocci): "Così da Ambrogio discesero due altri elevetissimi ingegni: l'uno fu Simone Barocci, fra moderni ancora il più eccellente nel lavorare gli stromenti matematici; perchè studiando sotto la disciplina di Federico Comandino Urbinate, illustre ristauratore delle scienze matematiche, si diede a fabbricar compassi, squadre, astrolabi ed altre macchine, nelle quali acquistossi tanta fama che portò il nome suo, ed i suoi lavori in ogni parte ed arricchì la sua patria di sì nobile officina, che ancora dura in Urbino. L'altro figliuolo di Ambrogio fu il nostro Federico Barocci (...)."

[2]Baldi, referring to the authority of Pappus and Atheneus, states that the master craftsmen, like master-clockmakers or constructors of the *automata* must have a good cognition of mathematics and particularly of mechanics, cf. *Automata*, fol. 10v: "Maestro di queste machine <automati>, scondo Pappo et Atheneo, non può essere se non colui che ha buona cognitione delle mathematiche e principalmente di quella parte che serve alle machine".

[3]Together with E. Gamba, we intend to publish an article about this interesting topic in the near future: it is emblematic for the close connection between the technical, "scientific" and political world in the Duchy of Urbino.

in the formation of Prince Francesco Maria della Rovere himself -[1] and was on the other hand closely connected to the Duke, as one of the most esteemed and best paid members of the court.[2] Interestingly, a table of contents of a planned treatise on fortification of Muzio Oddi reports references exactly to Count Thiene and Guidobaldo.[3]

Generally, there seems to have been a broad interest in mathematical instruction in the Duchy of Urbino, as several independent sources testify. This concerns particularly the members of the intermediate cultural stratum. They usually were not instructed in Latin, let alone in philosophy, as, in contrast, were the noblemen. In the most cases, their formation took place at the "abacus-schools", were they learned, amongst others, a sound foundation of mathematics. As far as the specific Urbinate context is concerned, the following account of Baldi in *Commandino's Vita* is interesting in regard:[4]

> But then he <Commandino> was insistently begged, particularly by the youth of the country, to translate <the *Elements* of> Euclid in our language for the benefit of who did not know Latin. <Commandino> could not reject and translated it diligently and made it print <in 1575>.[5]

The "youth" seems to be identical with the future engineer-architects of the intermediate cultural stratum: surely they did not speak Latin, as they apparently were not able to read Commandino's Latin Euclid-edition of 1572, and moreover they were interested in mathematics. Another confirmation of the general demand and interest in mathematical writings, particularly in Guidobaldo's, by a group of scholars without cognition of Latin in the Urbinate territory, is constituted by the existence of several vulgar translations of the Marchigian mathematician's

[1] Cf. ASF, Ducato di Urbino, Classe I, 222, fol. 722r (letter from F. Agatone to Duke Guidobaldo II, September 4th 1568): "Ebbi la <lettera> di V.Ecc.a delli 30 <agosto> che mi ha accusato la ricevuta delle camozze, il costo de' quali, et così delli libri ch'io feci dare al Conte Giulio Thiene in cambio de quelli ch'egli aveva dato all'Ill.mo S.r Principe"

[2] Cf. Appendix I, I.4.4.

[3] Cf. BUU, Fondo del Comune, busta 120, cart. 3, fol. 420r: "Terzo <capitolo>: con che misure si facciano le [fossette] in generale (...) paradosso del Conte Giulio <da Thiene> della [lunghezza] delle ** e della larghezza della fossa della [pianura]. ** misure particolari. Quarto <capitolo> Dell'artelleria che non *** fosse invention come s'operi quanto (...) Del modo del [misurare] le palle; [porre] l'instrumento del S. Guidobaldo. Insegnare secondo il modo d'Erone come si fabricano i diametri delle palle secondo qualsivoglia grandezza."

[4] Cf. B. Baldi, *Vita di Federico Commandino*, in "Giornale de' Letterati d'Italia", 1714, 19, Articolo VI, pp. 140-185. See also the commented version edited by E. Nenci (Milan, Angeli, 1998).

[5] *Vita di Commandino*: "(...) ma pregato con molta instanza, e particolarmente dalla gioventù della patria, ch'egli volesse, a beneficio di chi non possedeva latino, trasferir l'Euclide nel nostro idioma, non potendo negarlo, tra//dusselo con molta diligenza e fecelo stampare <nel 1575>."

Latin works:[1] the beginning of an Italian version of the *Paraphrasis*,[2] translated by Niccolò Vincenzi;[3] and the beginning of the *Perspectivae Libri sex*.[4]

Apart from the problem if the formation of the engineer-architects was wanted by the Duke or not, the question arises what might have been the contents or works studies in these lessons. This obviously is a problem that goes beyond the purpose of the present subsection, but the collected documents permit to give an at least partial answer: surely the study of mechanical machines was a part of the formation, and the basis text of this part seems to have been the *Mechanicorum Liber*, as testified by Guerrini's letter to Clavius.
On the other hand, also the study of the barycentre-theory must have made part of the instruction: in fact, Guidobaldo emphasises in the preface of the *Paraphrasis* the importance of this branch of mechanics, in particular of Archimedes's *Equilibrium of Planes*. In fact,

> we must rightly conclude that nobody has to be considered as scholar of mechanics (*mechanicos*) who does not know the writings of Archimedes.[5]

This conception seems to imply that the study of the *Equilibrium of Planes* or excerpts of it constituted a part of Guidobaldo's lessons to the engineers-architects. In this context, the question of the genesis of the *Paraphrasis* is highly interesting: some of its elements seem to suggest that it was conceived as an

[1] A similar phenomenon caused the vulgar translation *Le Mechaniche* of Guidobaldo's *Mechanicorum Liber*, translated by Filippo Pigafetta at instance of Giuliano Savorgnan. The latter was a famous engineer and military man, and therefore relatable to the intermediate cultural stratum. His correspondence with Pigafetta, conserved at the Biblioteca Ambrosiana at Milan, shows that he was interested in powerful machines he need in order to transport heavy loads such as cannons.

[2] Cf. BUU, Fondo della Congregazione di Carità, Busta 47, fasc. II, fols. 9-56. The translation breaks off in the middle of the eighth proposition, and towards the end the figures are missing (while the spaces of the planned figures remained empty).

[3] N. Vincenzi, a relative of Muzio Oddi, was apparently interested in the construction of sundials and in geometrical problems, as his extant writings evidence. In fact, BUU, Fondo della Congregazione di Carità, Busta 47, fasc. II, fols. 1r-175r conserves the following writings authored by him: "Modi diversi di formare li quattro horologi orizzontali, antico, boemo, francese ed italiano, nelle superficie piane" (fols. 5-8); "Commentari dele cose geometriche e scolii brevissimi dei sei libri geometrici di Euclide" (fols. 81-175); moreover, other incomplete translations made by him are conserved, of the first book of Alhazen's *Perspective* and of the *Perspective* of Witelo.

[4] Cf. BUU, Fondo del Comune, Busta 120, fasc. 3, fols. 428r-436v.

[5] Cf. *Paraphrasis*, p. 21: "Nihil enim in hoc genere <mechanico> demonstrari potest, quod his non indigeat scriptis <mechanicis Archimedis>. Et quod admirabilius est, nos non solum prof fundamento suscipere posse ad aliquod demonstrandum theoremata in his libris demonstrata, verum etiam ab his demonstrationibus perdiscerere ipsum modum argumentandi et demonstrandi, ut suis locis ostendemus. Ita ut vere concludendum sit, neminem prorsus inter mechanicos connumerndum fore, qui haec Archimedis scripta ignorat."

elementary comment, clearing the *basic* notions of the Archimedean mechanics, just like a textbook. In fact, in a letter to Galileo, he characterised the writing as "a work for beginners",[1] and certain passages of the book seem to refer to elementary questions stemming from the interaction with his environment (cf. the next paragraph, "The problem of the line passing through the centre of gravity").

Traces of the influence of Guidobaldo's ambiance on his scientific work

Until now we have concentrated to Guidobaldo's activity as instructor of future architects and engineers. But as subsection IV.1.1 has documented, this was part of a much wider context of his contact with other architects and engineers, which whom he collaborated. Now, it is time to occupy with the traces of his interaction with this ambiance, some of which we expose in the following.

UCLA, ms 170/624, folio 79. One of them is contained in the manuscript 170/624 of the University of California (Los Angeles):[2] folio 79 reports two problems of mechanical and of geometrical nature, entitled "<Problems> proposed by Sir Marquis of Carrara", namely Alderano Cybo-Malaspina.[3] He had dwelt a certain period at the court of Urbino and seems to have been both interested and talented in mathematics: he participated in Commandino's lectures on mathematics and was dedicated the latter's Latin translation of Aristarchus's *On the Sizes and Distances of the Sun and Moon* (1572). As one of Commandino's disciples he was well acquainted with Guidobaldo. It might have been in this period that he apparently proposed Guidobaldo to solve the following problems:

> Al pie d'un monte, il qual è alto dalla pianura li 3/8 della sua base, et ha di salita passi numero 1500, trovasi un pezzo di artiglieria la qual commodamente si conduce da luoco a luoco per la pianura con tre para di bovi. Or' volendo condurla alla cima di detto monte si ricerca saper quanti para di bovi li voranno.
> Un pentagono equilattero et equiangolo che per lato è 6. Similmente è un eptagono equilatter et equiangolo che per lato è 9. Si ricerca, volendo constituire un ottagono equilattero et equiangolo, di cui l'area

[1] Cf. BNCF, ms Gal. 88, fol. 13r (March 23rd 1588): "Confesso la mia negligentia in esser stato troppo a risponderLe, ma mi sono lasciato trasportare dal tempo, che volevo mandarGli il libro <*Paraphrasis*> il quale è apunto finito di stampare adesso. Io conosco benissimo che V.S. non ha punto bisogno di questo comento, ma il libro è fatto per i principianti." Published in G. Galilei, *Opere*, cit.

[2] The notice about the existence of this manuscript is contained in P. Neville, *The Printer's Copy of Commandino's Translation of Archimedes, 1558*, in "Nuncius", VI 2 (1986), pp. 7-12.

[3] Alderano Cybo-Malaspina (1552-1606) was the first born son of the marquis of Massa and Carrara Alberico I (1534-1623) and died before his father, so he did not ever have the govern over his family.

sua superficiale sia eguale all'area superficiale delle due figure suddette unite insieme, quanto sarà per lato.

Proposti dal S.r Marchese di Carrara

The first question, to which we confine ourselves here, obviously corresponds to the problem of the inclined plane. On the successive pages of the manuscript – unfortunately hardly readable – Guidobaldo attempted to solve the problems. In the case of the inclined plane, Guidobaldo seems to have accepted Pappus's solution of the eighth book of the *Collectiones Mathematicae* that he knew thanks to Commandino's works on it in those years.
If our hypothesis of dating these problems to the first years of the 1570s is right,[1] Alderano Cybo's impulse led to Guidobaldo's first study of the problem of the inclined plane: then, after this *stimulus*, he turned to the question in his *Mechanicorum Liber*, where he referred to Pappus's solution as well.

Some entries in the *Meditatiunculae*. Guidobaldo's notebook shows several traces of his occupation with practical questions and of his interaction with his ambiance.[2] So, he approached problems like the measurement of the height of a tower (p. 9) and of the difference of level between two points (p. 10), the levelling of a cannon (pp. 39/40); advantageous dimensions and arrangements of certain machines (pp. 59-61; pp. 135/36), with a reasoning about costs and the space required by them; the design of two instruments to draw parallel lines (p. 112), the problem how to draw a map (i.e. a problem relative to projection, p. 160). The connections of these topics with Guidobaldo's activities in the capacity of architect, military engineer, constructor and inventor of scientific instruments are quite obvious.[3]

A particularly interesting entry is constituted by page 6:[4] it deals with a geometrical problem which consists in showing that two certain lines in a rectangular triangle are equal (cf. figure IV.1). The upper left margin reports Guidobaldo's title "Problem proposed by Count Giulio da Thiene" (whom we have already met some pages before).

[1] In fact, it seems plausible that this problem was presented in the context of Guidobaldo's and Alderano Cibo's contact in occasion of Commandino's lecutres. This contact diminished from Francesco Maria II's accession to the throne in September 1574, before the lectures ended for good at the end of 1575, due to Commandino's death.

[2] A more detailed analysis of the entries of the *Meditatiunculae* which are connected with mechanics, is exposed in VI. A transcription of the manuscript is R. Tassora, *Le Meditatiunculae de rebus mathematicis di Guidobaldo del Monte*, Tesi di Dottorato 2001, Università di Pisa.

[3] Moreover, at the end of the *Meditatiunculae*, there are several pages that indicate a scientific exchange with Galileo. These pages deal with the topics: infinity in mathematics (p. 232), the hydrostatic balance (pp. 232-234), strings of musical instruments (p. 235), the trajectory of a projectile (p. 236), the inclination of roofs (pp. 236/37) and of the water intake of mills (p. 236)

[4] The full transcription of it is exposed in Appendix II, I.8.3.

Interestingly, Guidobaldo later[1] comments this solution at the bottom of the page: "This problem helps a lot in perspective: if the eye is in a and if one sees the line db, one can find the line fg which appears to have the same size as db, being the section equidistant to de".
This note is highly remarkable: with all probability, Guidobaldo realised the importance and usefulness of this problem for perspective when he was working on the *Perspectivae Libri sex* – in fact, a consistent part of the *Meditatiunculae* is dedicated to the studies of the rules of perspective. If we accept Tassora's dating and her argumentation in favour of the substantially chronological structure of the notebook entries,[2] we can suppose the problem to stem from 1586/87 or earlier. Then, years later – Guidobaldo seems to have begun to work on the *Perspectivae Libri sex* around the year 1590 – when he was dealing with perspective, he remembered this problem, posed years before by Count Giulio da Thiene and integrated it in his treatise.

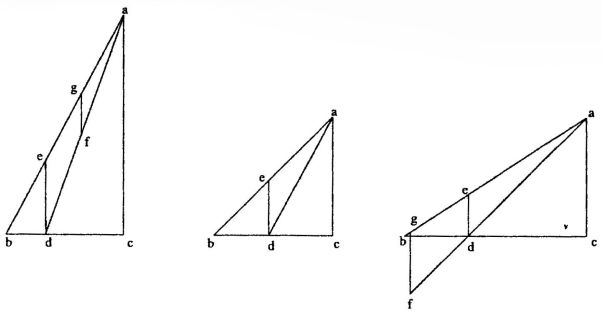

Figure IV.1: Guidobaldo shows in the first and third case that gf is equal to bd, in the second ed equal to bd.

The problem of the line passing through the centre of gravity. At the end of the first book of the *Paraphrasis*, Guidobaldo deals with the following problem: a plane figure is necessarily divided in two parts of equal area by a line passing through its barycentre? He proves that generally the parts after the intersection do *not* have the same area. The same demonstration, different wordings apart, can also be found in the *Mediatiunculae*, on page 116.[3]
An idea about the provenance of this problem – essentially the only proposition that Guidobaldo adds to the Archimedean theorems of the *Equilibrium of Planes* – is given by the following letter from Francesco Guerrini, Guidobaldo's disciple, to Clavius, few months after the death of the Marchigian mathematician:[4]

[1]It is the different ink used by Guidobaldo to write these lines, which tell us that he commented this entry in a second moment. Further, he wrote this comment in Italian, and not in Latin which is used for the demonstration.

[2]Cf. R. Tassora, *Le Meditatiunculae de rebus mathematicis di Guidobaldo del Monte*, cit.

[3]The complete transcription of both demonstrations is exposed in VI.2.5.

[4]Cf. APUG, 529, fols. 112r-113v; published in Chr. Clavius, *Corrispondenza*, critical edition by U. Baldini and P.D. Napolitani, vols. 7, Pisa, Edizioni del Dipartimento di Matematica

After the death of the Most Illustrious Guido dal Monte, may God rest his soul, several gentlemen of the city of Pesaro have asked me to show them the practice of the *Mechanicorum Liber* of the aforesaid Sir, as I do. We have already finished the first chapter *Della Libra* and at the beginning there has been a great controversy about the definition of the centre of gravity, about these words:
«In fact, if a plane is drawn through this centre, intersecting the figure in an arbitrary way, so it will divide it always in equiponderating[1] parts.»
And if one wanted to insist in the wording "intersecting in an arbitrary way", it would seem that the two parts, after the section, would weigh equally, but in reality the contrary can be proven. (...)
I beg You to say me Your opinion which will be highly useful for me (...).

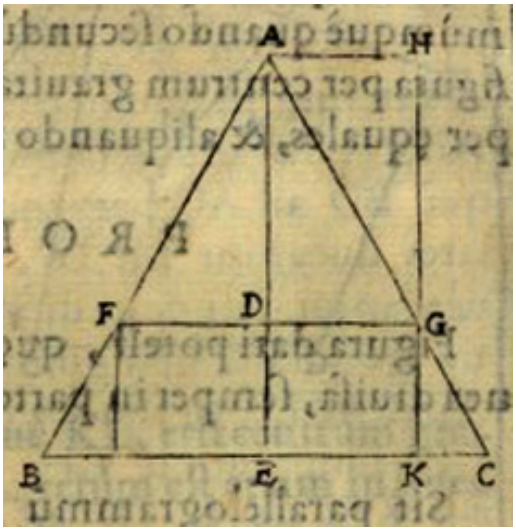

Figure IV.2: Guidobaldo shows in the last proposition of the first book of the *Paraphrasis*, that AFG and $BCGF$ do not have the same area (D is the barycentre of the triangle).

So, Guerrini's letter (and the discussions among the "gentlemen of the city of Pesaro") concerns exactly the same problem approached in last proposition of the *Paraphrasis*. This might obviously be a coincidence. Yet, in the light of what we have seen in the present section – Guidobaldo's activity as teacher of future architects and engineers, his integration of also other *stimuli*, deriving from his ambience, in his works (as the example of page 6 of the *Meditatiunculae*

dell'Università di Pisa, 1992.

[1]This is a neologism to translate the Latin word "aequeponderare", one of the basic notions of the Archimedean barycentre theory. The reason for this choice is exposed in Part B, II.3.

evidences) – a different conclusion seems more plausible: Guidobaldo has met this problem during his lessons to architects and engineers, to whom he taught the Archimedean theory of the *centre of gravity* – in effect, it is probably this the *basic* problem of the barycentre theory: the distinction between *weight* and (*proto-*)*moment* -[1] and then included it in the *Paraphrasis*.

IV.2 Key aspects of the *Mechanicorum Liber*[2]

Guidobaldo's principal mechanical work is dedicated to explicate the operation mode of the five so-called «Simple Machines», i.e. lever, pulley, winch, wedge and screw – a topic that had its roots in ancient mechanics, in writings composed by Heron, Pappus and Aristotle.[3] Guidobaldo elaborates a geometrical model for the machines and succeeds in explaining their operation by considering their geometrical properties and using the basic concepts of the Archimedean theory of mechanics.

Compared to his model, i.e. the treatment of the Simple Machines at the end of Pappus's eighth book of the *Collectiones Mathematicae*, there are two fundamental divergences: while Pappus dwelt also on the construction of the respective machines,[4] Guidobaldo ignores this aspect completely. On the other hand, the mathematical relations between the weights and the needed forces are not proved in Pappus: every section reports the reference that their ratios will be demonstrated in the following,[5] but the respective part at the end of the eighth book must have got lost.[6] Guidobaldo, instead, presents a completely developed axiomatic-deductive structure – absent in the version of the Pappian writing came down to us – and proves the proportions between the applied forces and weights.

[1] For futher information on this topic, cf. Part B, chapter II.

[2] Further literature on this work: S. Drake, I.E. Drabkin, *Mechanics in Sixteenth-Century Italy*, Madison, The University of Wisconsin Press, 1969; P. Damerow, J. Renn, *Guidobaldo del Monte's* Mechanicorum Liber, epubli, 2010.

[3] For further information in regard, cf. Part A, chapter III.

[4] For example, the beginning of the section on the winch reads, in Commandino's edition (cf. fols. 329v-330r): "De Axe in peritrochio. Axis igitur in peritrochio hoc modo construitur: Lignum accipere oportet firmum, quadratum perinde ac tignum: eiusque extrema contorquentes rotunda facere et choinicidas circumponere aereas coagmentatas axi, ita ut iniectae in foramina rotunda immoto quodam pegmate expedite vertantur, cum foramina habeant τρηβεῖς aereos choinicibus subiectos. Vocatur autem id lignum, quod dictum est *axis* et circa medium axem circum ponitur tympanum, habens foramen quadratum axi congruens, ut eodem tempore et axis et peritrochium vertatur. Constructio igitur declarata est. Usus autem est, qui dicetur: (...)"

[5] E.g. for the lever, fol. 330r (the emphasises are ours): "quanto propinquius oneri ponitur hypomochlium, tanto facilius pondus movetur, ut *deinceps ostendemus*" or on the pulley (fol. 330v): "Quam autem ob causam cum plura sint membra, facilitas movendi subsequatur, *ostendemus*, et cur alterum caput ex manente loco suspendatur."

[6] In fact, also Hultsch's critical edition, more complete compared to Commandino's edition, does not present the mathematical demonstrations.

In particular, he reduces the operation mode of any Simple Machines to the lever, and consequently is able to apply the law of the lever.

The *Mechanicorum Liber* (1577) had a deep impact on mechanics, was "the most authoritative treatise on statics to emerge since antiquity, and it remained pre-eminent until the appearance of Galileo's *Two New Sciences* in 1638".[1] The numerous re-editions and translations in Italian, German and (partly) in Spanish document the interest it had aroused.[2]
In its reception, we might track three main interests: the first, orientated to the technical consequences of Guidobaldo's description of the machines, as in Agostino Ramelli's *Le diverse et artificiose machine*,[3] or in Bonaiuto Lorini's *Le fortificazioni*,[4] addressed to engineers and architects; the second, more theoretically orientated approach, regarding the geometrisation of physical objects like in Galileo's *Mecaniche*,[5] in Davide Imperiali's *Le Meccaniche mie*,[6] or in Oreste Biringucci's Italian translation of Piccolomini's paraphrase on the *Quaestiones Mechanicae*;[7] and finally the interest in Guidobaldo's fundamentally new treatment of the isostatic balance and the indifferent equilibrium, about which Guidobaldo's correspondence informs us.[8]

These different readings and interests correspond to the principal merits of Guidobaldo's treatise: firstly, the development of a mathematical model of the Simple Machines:[9] revealing the connection between their operation mode and geometry, Guidobaldo considerably contributed to abandon the mythologising conception of their "miraculous" effects; secondly, his first steps to the identification of a generally valid *compensation principle* for mechanical machines; thirdly, Guidobaldo's discovery of the indifferent equilibrium: the *Mechanicorum Liber* thus constitutes the first work which presents all three forms of equilibrium, im-

[1] Cf. P.L. Rose, *The Italian Renaissance of Mathematics*, cit., p. 222.
[2] Cf. subsection I.2, page 39.
[3] A. Ramelli, *Le diverse et artificiose machine*, Paris, Ramelli, 1588.
[4] B. Lorini, *Le fortificazioni*, Venezia, Rampazetto, 1597.
[5] Cf. G. Galileo, *Le Mecaniche*, critical edition by R. Gatto, Firenze, Olschki, 2002.
[6] Cf. R. Gatto, *La meccanica a Napoli ai tempi di Galileo*, Napoli, Città del Sole, 1996.
[7] A. Piccolomini, *In Mechanicas Quaestiones Paraphrasis*, Roma, 1547. Italian translation by O.V. Biringucci, Roma, 1582.
[8] A detailed analysis of this central topic of Guidobaldo's mechanics is exposed in Part B, I.
[9] On the concept of mathematisation or geometrisation of physical objects before Newton, cf. B. Vitrac, *Mécanique et mathématiques à Alexandrie: le cas de Héron*, Oriens-Occidens, 2010 : "il ne s'agit évidemment pas de formuler, puis d'appliquer des lois naturelle décrivant les phénomènes à l'aide d'équations, algébriques ou différentielles. Ni Archimède ni Héron n'avaient les moyens d'anticiper sur Newton ou Lagrange. Mais le recours à la géométrie constitue indiscutablement une forme de rationalisation, que l'on trouve aussi bien au niveau des explications causales que dans les constructions."

portant in many branches of physics. While we will analyse the second aspect in subsection IV.2.4, and the third in Part B, chapter I, let us here dwell a bit on the first one:

Guidobaldo had furnished in his *Mechanicorum Liber* a way how to reduce the functionality of the Simple machines to elementary geometrical rules and proportions. While before his work their operation was explained either by "miraculous effects" or by qualitative argumentations (as in the *Quaestiones Mechanicae*, Guidobaldo's approach was radically different: he offered to the reader a clear exposition. Emblematic for the modelling of a geometrical models is the winch: on folio 106v Guidobaldo had reported a winch as it was famous to the readers of those times, on the folio beside, fol. 107r, he opposed its mathematical abstraction, evidencing the relevant lines and proportions (cf. figures IV.3 and IV.4).

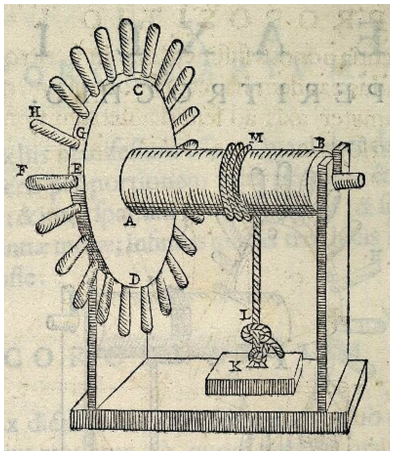

Figure IV.3: The real model of a winch.

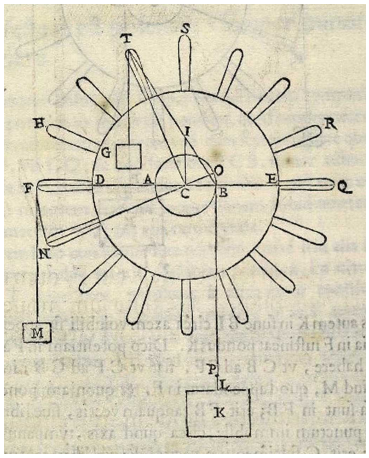

Figure IV.4: Guidobaldo's geometrical model of the winch on the folio beside.

Similar models are exposed for the other Simple Machines (cf. IV.5 and IV.20). These models served to scholars who had contact with machines, like architects, engineers, but also the constructor of similar machines, to organise their practical knowledge.

In the present section, we first expose a short overview on the content. In the following, we approach several of the key passages and topics of the book: we expose a detailed summary of the fourth proposition of *De Libra* where Guidobaldo (with its indifferent equilibrium and the confutation of the opponents' arguments), as it has often been misinterpreted and exploited to show Guidobaldo's alleged excessive mathematical rigour; this is connected with the question of the

convergence of the lines of action, which will be analysed in the successive subsection. Finally, we deal with Guidobaldo's distinction between *potentia sustinens* and *potentia movens* as well as with the first steps to the identification of a *compensation principle* for mechanical machines.

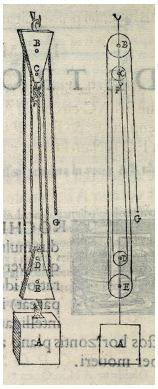

Figure IV.5: The pulley and its geometrical model.

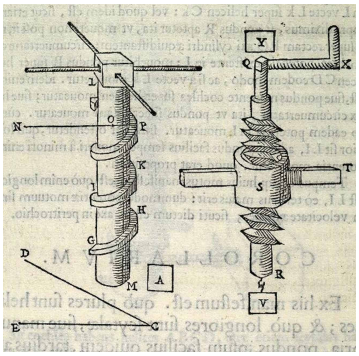

Figure IV.6: The representation of a "real" screw besides its geometrical model.

IV.2.1 Overview of the content

Guidobaldo dedicates to each of the five Simple Machines a respective chapter, in the order *De Vecte* (on the lever), *De Trochlea* (on the pulley), *De Axe in Peritrochio* (on the winch), *De Cuneo* (on the wedge) and *De Cochlea* (on the screw). They are preceded by a lengthy chapter on the balance (*De Libra*). So, Guidobaldo changed the order of exposition compared to Pappus (there: winch, lever, pulley, wedge, screw).

The work opens with the dedication to Duke Francesco Maria II, Guidobaldo's fellow student of Commandino's classes and himself interested in mathematics, mechanics and fortification,[1], and with the preface. He emphasises the value of mechanics, underlining both the *utilitas* and the *nobilitas* of mechanics,[2] revisiting a topic that his master Commandino had once applied to mathematics.[3] In fact, Guidobaldo presents himself as his successor: after a long and famous

[1]Cf. Part A, chapter II.

[2]Cf. p. i (not numbered) "Duae res, Amplissime Princeps, quae ad conciliandas hominibus facultates, utilitas nempe et nobilitas, plurimum valere consueverunt. Illae ad exornandam mechanicam facultatem, et eam prae omnibus aliis appetibilem reddendam conspirasse mihi videntur";

[3]Cf. D. Bertoloni Meli, *Guidobaldo dal Monte and the Archimedean Revival*, in "Nuncius", VII 1, 1992, pp. 3-34.

eulogy of his master, he slightly criticises his negligence of mechanics,[1] that he now wants to study with even more eagerness.[2]
The Marchigian mathematician announces his "program" of mechanics: he always wanted to follow Archimedes, and as Pappus the Syracusan mathematician, no one could criticise Guidobaldo to follow Pappus's exposition of the Simple Machines.[3] Yet, mechanics is not subordinated only to mathematics, but also to "physics", i.e. to natural philosophy.[4] Guidobaldo would have refined this concept in the preface of the *Paraphrasis*.
Guidobaldo complains about a certain lack of knowledge about Archimedes's *Equilibrium of Planes*.[5] In effect, he feels constrained to insert a chapter on the balance, before the actual treatment of the Simple Machines, in order to lay sound foundations:

> It is astonishing which disaster Jordanus has made (who was in the highest esteem amongst modern scholars) and others who intended to agitate this subject.[6]

[1]This critique is rather surprising: with *De centro gravitatis solidorum* and *De iis quae vehuntur in aqua* (both 1565), Commandino published two important works on the centres of gravity, considered as one of the main parts of mechanics by Guidobaldo himself.

[2]Cf. *Mechanicorum Liber*, pp. viii-ix: "Emicuit tamen inter istas tenebras (quamvis alii quoque nonnulli fuerint praeclasissimi) Solis instar Federicus Commandinus, qui multis doctissimis elucubrationibus amissum mathematicarum patrimonium non modo restauraviut, verum etiam auctius et locupletius effecit. Erat enim summus iste vir omnibus adeo facultatibus mathematicis ornatus, ut in eo Architas, Eudoxus, Heron, Euclides, Theon, Aristarcus, Diophantus, Theodosius, Ptolemaeus, Apollonius, Serenus, Pappus, quin et ipsemet Archimedes (siquidem ipsius in Archimedem scripta Archimedis olent lucernam) revixisse viderentur. (...) Ille tamen perpetuo in aliarum mathematicarum explicationem versans, mechanicam facultatem, aut penitus praetermisit, aut modice attigit. Quapropter in hoc studium ardentius ego incumbere coepi, nec me unquam per omne mathematum genus vagantem ea solicitudo deseruit, ecquid ex uno quoque decerpi ac delibari possit, quo ad mechanicam expoliendam et exornandam accomodatior esse possem."

[3]*Mechanicorum Liber*, p. vi: "Talesque fuerunt, et praesertim Pappus, ut eum me ducem sequentem nemo (ut opinor) culpaverit. Quod et propterea libentius feci, quod ne latum quidem unguem ab Archimedeis principiis Pappus recedat. Ego enim in hac praesertim facultate Archimedis vestigiis haerere semper volui;"

[4]*Mechanicorum Liber*, p. viii: "reperiuntur enim aliqui, nostraque aetate emunctae naris mathematici, qui mechanicam tum mathematice seorsum, tum phisice considerari posse affirmant; ac si aliquando, vel sine demonstrationibus geometricis, vel sine vero motu res mechanicae considerari possint. Qua sane distinctione (ut levius cum illis agam) nihil aliud mihi commincisci videntur, quam ut dum se, tum phisicos, tum mathematicos proferant, utraque (qupd aiunt) sella excludantur. Neque enim amplius mechanica, si a machinis abstrahatur et seiungatur, mechanica potest appellari."

[5]Cf. *Mechanicorum Liber*, pp. vi-vii: "Quem sane libellum, si aetatis nostrae mathematici sibi magis familiarem adhibuissent, reperissent sane sententias multas, quas modo ipsi firmas et ratas esse docent: subtilissime, atque verissime convulsas et labefactas."

[6]Cf. *Mechanicorum Liber*, p. x: "Verum quo facilius totius operis substructio ad fastigium suum perduceretur, nonnulla quoque de libra fuerunt pertractanda et praesertim dum unico pondere alterum solum ipsius brachium penitus deprimitur: Qua in re mirum est quantas

With this clear reference to the isostatic balance and the fourth proposition of *De Libra* (cf. subsection IV.2.2), and with an eulogy of Duke Francesco Maria II, the preface ends and the main part of the treatise begins.

It is introduced by two definitions of the basic notion of Archimedean mechanics *centre of gravity*, which remained undefined in Archimedes's writings passed down to us. So Guidobaldo recurred to Pappus's, exposed in the eighth book of the *Collectiones Mathematicae*,[1] and to Commandino's,[2] introduced in *De centro gravitatis solidorum* (1565). Strangely, Guidobaldo reports the term *moment* in the second definition, but will never in his writings specify its properties, nor will he try to develop a mathematical theory of it – he preferred to use the other notion, genuine Archimedean, of *aequeponderare*.[3]
Six axioms, subdivided in three *Communes Notiones* and three *Suppositiones*, underline the deductive-axiomatic style of the treatise: the first three occupy with *equiponderating*[4] bodies, stabilising the additivity and reflexivity of this concept.[5] The remaining three with the concept *centre of gravity*, postulating the existence and uniqueness of the barycentre, the invariability of its position under translations or rotations and the movement downwards of any body according to its barycentre.[6]

The chapter *De Libra* (fols. 2r-37v) begins with the proposition that if an arbitrary body, held by a line supporting its barycentre, is at rest, the line necessarily is perpendicular to horizon. With this proposition, Guidobaldo proves the following three theorems on three different types of balances: a balance, with equal weights in equal distances, with rotation centre above the beam, turns to

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fecerint ruinas Iordanus (qui inter recentiores maximae fuit auctoritatis) et alii qui hanc rem sibi discutiendam proposuerunt."

[1] *Mechanicorum Liber*, fol. 1r: "Centrum gravitatis uniuscuiusque corporis est punctum quoddam intra positum, a quo si grave appensum mente concipiatur, dum fertur, quiescit et servat eam, quam in principio habebat postionem, neque in ipsa latione circumvertitur."

[2] *Mechanicorum Liber*, fol. 1r: "Centrum gravitatis uniuscuiusque solidae figurae est punctum illud intra positum, circa quod undique parte aequalium momentorum consistunt. Si enim per tale centrum ducatur planum figuram quomodocunque secans semper in partes aequeponderantes ipsam dividet."

[3] For a detailed analysis of Guidobaldo's theory of *proto-moment*, cf. Part B, II.

[4] This neologism imitates the Latin verb *aequeponderare*, on its part the translation of the Greek ἰσορροπεῖν which is used by Archimedes. As we will explain in Part B, II.3, in particular page 349.

[5] *Mechanicorum Liber*, fol. 1v: "Communes Notiones: I. Si ab aequeponderantibus aequeponderantia auferantur, reliqua aequeponderabunt. II. Si aequeponderantibus aequeponderantia adiiciantur, tota simul aequeponderabunt. III. Quae eidem aequeponderant, inter se aeque sunt gravia."

[6] *Mechanicorum Liber*, fol. 1v: "Suppositiones: I. Unius corporis unum tantum est centrum gravitatis. II. Unius corporis centrum gravitatis semper in eodem est situ respectu sui corporis. III. Secundum gravitatis centrum pondera deorsum feruntur."

the horizon if it is brought in any inclined position and then left free (Prop. II; cf. figure IV.7). On the contrary, a balance with rotation centre *below* the beam, moves further away from the horizontal position, once removed from it and left free (Prop. III, cf. figure IV.8). And finally, a balance with the rotation centre exactly on the beam itself (called «isostatic balance») remains at rest also in inclined positions, if it is left there (Prop IV, cf. figure IV.9).

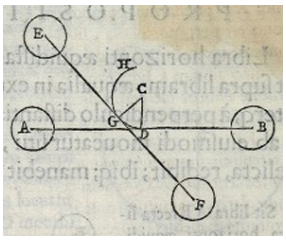

Figure IV.7: The balance with rotation centre C above the beam – stable equilibrium.

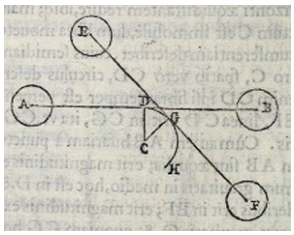

Figure IV.8: The balance with rotation centre C below the beam – unstable equilibrium.

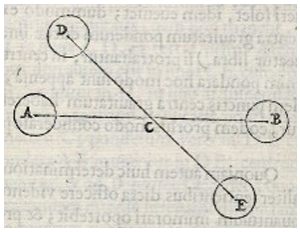

Figure IV.9: The isostatic balance with rotation centre C exactly on the beam – indifferent equilibrium.

While the first two statements were essentially known from antiquity, the last proposition about the indifferent equilibrium on isostatic balances, is innovative and had not been exposed in mechanical treatises before.[1] On the contrary, the diffused solution for the isostatic balance in the sixteenth century, furnished by Jordanus and adopted by Tartaglia (partly also by Cardano), claimed the return of the balance to the horizontal from any inclined position. Correspondingly, Guidobaldo inserts a lengthy digression after the fourth proposition in order to show the falsity of his opponents' argumentations, cf. subsection IV.2.2: in effect, it covers some fifty pages and therefore constitutes a fifth (!) of the entire *Mechanicorum Liber*. This fact, paired with other circumstances, underlines the importance of the topic in the *Mechanicorum Liber*, and as chapter I (Part B) will evidence also far beyond Guidobaldo's first mechanical writing.
The remaining three propositions of *De Libra* (including some corollaries) deals with systems of weights on the balance: Proposition V clears how to substitute two weights in arbitrary positions on the balance with only one weight without changing the initial effect of the two weights. Proposition VI contains interesting information on the formalisation grade of Guidobaldo's *proto-moment*,[2] its corollary a treatment of the Roman balance (*statera*). The seventh and last proposition of *De Libra* presents a recursive proceeding how to find the centre of gravity of a balance on which several weights are fixed.

[1] This statement refers to printed books of mechanics: in effect, in a manuscript, Leonardo da Vinci shows to have been aware of the existence of the indifferent (codex G, fol. 79r) – cf. Part B, chapter I, footnote 3 on page 266.

[2] For further information on this topic, cf. Part B, II.4.

The chapter on the lever (*De Vecte*, fols. 38r-61v) contains fifteen propositions. In contrast to the balance, the lever is subject to the effects of a force on the one hand, and of a weight on the other. However, Guidobaldo identifies the action of the force as the equal effect of a certain weight's gravity – in fact, the forces are symbolised as weights in the figures. The first three propositions expose the three types of lever, according to the respective collocation of fulcrum, weight and force. Proposition IV, relevant for the successive chapters, states that the spaces covered by the weight and by the force are in the same ratio as their distances from the fulcrum. The next proposition serve to demonstrate that the applied force varies according to the inclination of the lever and the way in which the weights are consolidated to the lever: as the projection of the centre of gravity on the beam varies with the inclination of the lever,[1] in the cases in which the respective weight is attached *above* or *below* the lever, the position where the weight bears down changes (cf. figures IV.10 and IV.11). In the case in which the barycentre of the weight lies on the lever itself, the force necessary to lift it does not depend on the inclination of the lever.
Propositions XIII and XIV deal with levers ballasted with more than two weights. The fifteenth and last proposition hints at the treatment of the material lever, i.e. endowed with gravity.

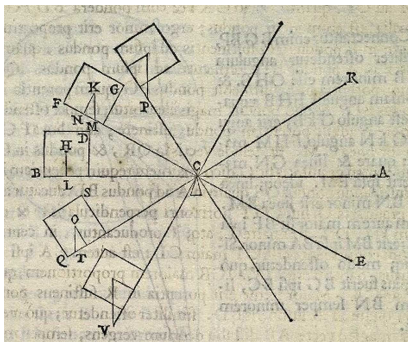

Figure IV.10: The case of weights fixed *above* the lever.

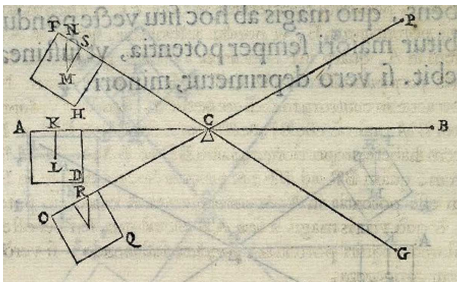

Figure IV.11: The case of weights fixed *below* the lever.

The chapter on the pulley, *De Trochlea*, is the most detailed one, as its extension (fols. 62r-105v) and the number of 28 propositions show. Guidobaldo reduces the pulley to the working principle of the lever: considering the pulley's wheel, its horizontal axis CDF (cf. figure IV.17) can be interpreted as a lever. Consequently, along a wheel fixed from above the force required to hold a weight is equal to the latter (Prop. I, cf. figure IV.17), while it is half the weight along a lower wheel (Prop. II; cf. figure IV.18).
Proposition III and V deal with a pulley as combination of an upper and a lower

[1]Note that the projection is not along the perpendicular, but directed to the centre of the world, according to Guidobaldo.

wheel: depending on their connection the required force is or half or a third of the weight: the last statement is demonstrated in Proposition IV by recurring to the lever. The following theorems deal with systems of pulleys with three to six wheels in Proposition in Proposition IX.

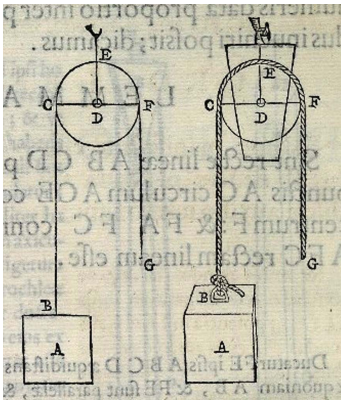

Figure IV.12: The upper wheel of a pulley – reduced to a lever CDF with fulcrum in D.

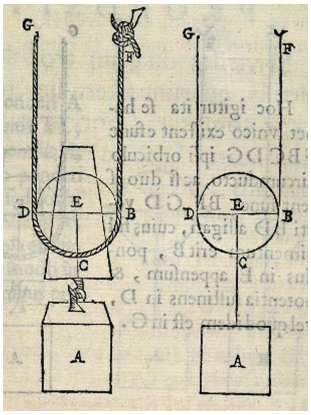

Figure IV.13: The inferior wheel of a pulley – reduced to a lever DEB with fulcrum in B and force in D.

The successive part is dedicated to the analysis of the spaces covered by the forces and weights as well as the times required to it.[1] First, Guidobaldo clears in Propositions X and XI that also in the case of movement it is legitimate to reduce the effect of the pulley to that of a horizontal lever. In this context, he reaches the (correct) conclusion for the inferior wheels that the force covers a space twice as long as the weight. Guidobaldo extends this statement also to systems of pulleys and reaches the following generalisation (Corollary I to Proposition XIV): the ratio of weight to force required to hold it equal to the ratio of the space covered by the moving force to the one covered by the weight. Or, in other terms (Corollary II of Proposition XXVIII): The easier a weight is move, the more time is required, and vice-versa. This means a decisive step to the comprehension of a kind of compensation in the effect of the machines: they permit to apply a major force, but the way to be covered by the force increases in the same way in which the required force diminishes.[2]
Afterwards, from Proposition XVI Guidobaldo considers the application of the force not along the cord, but the force is applied on the superior wheels by which

[1] *Mechanicorum Liber*, fol. 75r: "Post haec considerandum est, quonam modo vis moveat pondus, nec non potentiae moventis, ponderisque moti spatium, atque tempus." Guidobaldo's interest in such questions is one of the reasons why it is problematic and inappropriate to classify his mechanics as "statics".

[2] In effect, it was doubtlessly by the inspiration of this and similar passages that Galileo stated his *compensation principle* in *Le Mecaniche*.

the system gets lifted. He shows that in these cases the relations between forces and weights as well as the ratios of their covered spaces.
The end of the chapter is dedicated, analogously to *De Vecte*, to the problem, how to move a given weight with a given pulley, which he is able to resolve by recurring to the propositions before.

The chapter on the winch, *De Axe in Peritrochio*, is the shortest (fols. 106r-111v) of the treatise. The first of only two propositions suffices for Guidobaldo to expose its geometrical model and to state the quantitative ratio between the acting force and the weight. Again, the operation is reduced to the lever: the space from the handle to the middle point of the axis is interpreted as one arm of the lever, the radius of the axis as the other (cf. figures IV.3 and IV.4, the "real" *versus* the geometrical model). Interestingly, Guidobaldo does not completely resolve the case when the force does not act in the horizontal plane.[1]
Proposition IV of *De Vecte* permits him then to state again that the weight is to the force like the inverse ratio between the spaces respectively covered. The second proposition finally approaches again the problem how to move a given weight with a given force by the device of the winch – this is easily solvable, by choosing opportune scales and divisions of the axis.

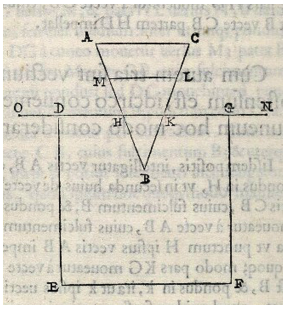

Figure IV.14: The first model of the wedge.

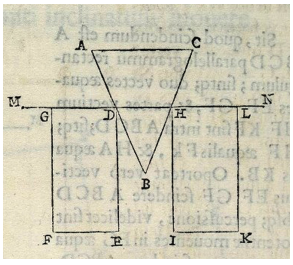

Figure IV.15: The second model of the wedge.

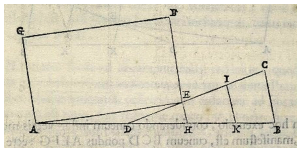

Figure IV.16: The third model of the wedge.

The chapter on the wedge, *De Cuneo*, (fols. 112r-119v) curiously does not contain any proposition. This lack of a formal structure reflects a certain perplexity of Guidobaldo in front of this problem -[2] comprehensively, if one considers that

[1]This was probably due to the fact, that Guidobaldo's mechanical theory was somewhat inconsistent concerning the conception of the convergence *versus* the parallelism of the lines of action; cf. IV.2.3.

[2]In effect, in a short epilogue on fol. 130 r/v, he admits that it does not seem possible to resolve the problem how to move a given weight with a given force by the device of the wedge, in contrast to the other Simple Machines. This would be due to the fact that the fulcrum of the lever, to which the wedge can be reduced, does move (cf. fol. 130v): "Datum vero pondus data potentia cunei instrumento movere, hoc minime fieri posso clarum esse videtur; non enim data potentia datum pondus super planum horizonti inclinatum movere potest, neque datum pondus

the force of percussion is connected to the concept *momentum* which had to wait still very long to be perceived as fundamental notion and to be formalised.[1] Correspondingly, Guidobaldo is not really convinced about the way how to reduce the operation of the wedge to the lever: is it a lever of the first kind, with fulcrum in H and weight in B (cf. figure IV.14), as claimed in the *Quaestiones Mechanicae*, or a lever of the second kind, with fulcrum in B and weight in H (cf. figure IV.15)?

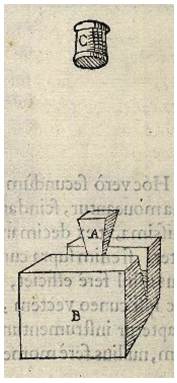

Figure IV.17: Guidobaldo's considerations on the force of percussion by the free fall of a weight.

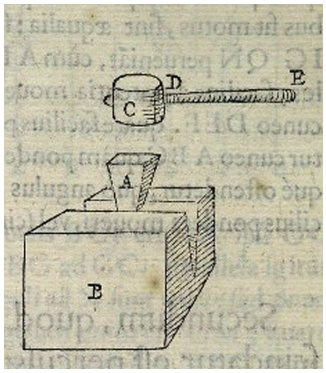

Figure IV.18: Guidobaldo's considerations on the force of percussion.

Guidobaldo tends to favour the second alternative, but remains rather noncommittal.[2] Finally, he present a third way which reduces the effect of a wedge to the problem of the inclined plane (cf. figure IV.16). It is in this context that Guidobaldo refers to Pappus's solution of the inclined plane, which he does not report, though.[3] Subsequently, he shows that the smaller the angle at the front of the wedge is the easier it moves and splits the object under pressure.

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a data potentia movebitur vectibus sibi invicem adversis, quemadmodum in cuneo insunt; cum in vectibus cunei propria veraque vectis proportio servari non possit. Vectium enim fulcimenta non sunt immobilia, cum totus cuneus moveatur."

[1] In effect, neither Galileo, nor Torricelli nor Descartes succeeded to formulate a satisfactory description of the force of percussion. Only towards the end of the seventeenth century, with works like Huygens's *De motu corporum ex percussione* (published in 1703), the laws of collision were stated correctly.

[2] Cf. *Mechanicorum Liber*, fol. 112v: "Simili quoque modo pars KG moveatur a cevte CB, cuius fulcimentum est B et pondus in k, ita ut k ipsius vectis CB partem kG moveat. Quod quidem *forsitan* rationi magis consentaneum erit." Another example on fol. 113v: "Quare considerando cuneum, ut movet vectibus sibi invicem adversis, *forsitan* eis potius utitur hoc secundo modo, quam primo." The emphasises are ours.

[3] It is only in the Italian translation of the *Mechanicorum Liber* that Pappus's demonstration appears. Here, in the *Mechanicorum Liber*, Guidobaldo confines himself to state (fol. 115r): "Hic motus facile ad libram vectemque reducitur, quod enim super planum horizonti inclinatum movetur ex nona Pappi octavi libri *Mathematicarum Collectionum* reducitur ad libram. Eadem enim est ratio, sive manente cuneo, ut pondus super cunei latus moveatur; sive eodem etiam

He terminates the chapter with some interesting remarks on the force of percussion (cf. figures IV.17 and IV.18): he identifies the velocity and the weight of a falling body as the two decisive magnitudes. Already here, we find the observation that even a most heavy weight can have a meagre impact compared to the force of percussion of a lighter body.[1]

The chapter on the screw, *De Cochlea*, (fols. 120r-130+1r) concludes the *Mechanicorum Liber*. In two propositions, he demonstrates that the screw can be interpreted as a cylinder around which an inclined planes is applied. This, again, allows the reduction of the screw to the lever, according to Pappus's ninth theorem in the eighth book of the *Collectiones Mathematicae*. The steeper the inclined plane around the cylinder is, the more force is required to move a weight with the screw – or in other terms: the screw with more windings at a given height, moves the weight more easily (cf. figure IV.19 and IV.20).

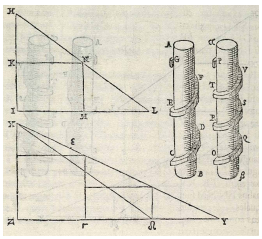

Figure IV.19: The upper wheel of a pulley – reduced to a lever CDF with fulcrum in D.

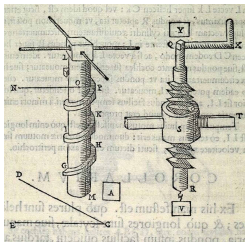

Figure IV.20: The inferior wheel of a pulley – reduced to a lever DEB with fulcrum in B and force in D.

moto, pondus adhuc super ipsius latus moveatur; tamquam super planum horizonti inclinatum."

[1]Cf. *Mechanicorum Liber*, fol. 118v: "Si enim supra cuneum maximum imponatur onus, tunc cuneus nihil fere efficiet, praesertim ictus comparatione. Quod si ad huc ipsi cuneo vectem, vel cochleam, vel quodvis aliud huiusmodi aptetur instrumentum ad cuneum ponderi intimius propellendum, nullius fere momenti prae ictu continget effectus."

IV.2.2 Proposition IV of the chapter *De Libra*[1]

One might call the Proposition IV the anomaly of Guidobaldo's work. The digression after the proposition in the proper sense and the associated argumentation against the scholars who had exposed contrary theories of the isostatic balance rages over about 50 pages, which is a fifth of the entire work – and this for *only one* proposition that is *part of a chapter* that *does not actually belong* to the topic of the Simple Machines.[2]

This fact is even more surprising as its content seems rather innocuous: Guidobaldo claims in the fourth proposition that a certain kind of balance, called isostatic balance (cf. figure V.8), can stay at rest even in an inclined position. In effect, the demonstration, in the proper sense, of the theorem is not longer than a single page. In effect, with the "appropriate" concepts it does not take much to prove the existence of the indifferent equilibrium. But against the background that he contradicted in this point practically the whole mechanical elite like Jordanus, Tartaglia and Cardano, who had considered as impossible what Guidobaldo now exposed, explains his efforts to provide a sufficiently sound theoretical foundation of his theory, including the confutation of his adversaries' arguments.

The direct prove

The theoretical foundation of this one-page, direct demonstration consists of essentially three elements: Pappus' definition of the centre of gravity;[3] the invariability of the position of a body's barycentre under translations and rotations (spoken modernly);[4] and the Archimedean conception to consider composed me-

[1] We will deal this proposition in a detailed way. The reason is that the indifferent equilibrium exposed in it constitutes a fundamental aspect of Guidobaldo's mechanics, cf. I. Yet, there is no complete English translation of this proposition available: Drake&Drabkin have published only excerpts which does not allow to comprehend the whole context of Guidobaldo's argumentation.

[2] Surely, the treatment of the balance was the necessary theoretical foundation of the work – yet, one cannot help but wonder about the remarkable length and detailedness of the chapter *De Libra* in general, and of the Proposition IV in particular.

[3] *Mechanicorum Liber*, fol. 1r: "Centrum gravitatis uniuscuiusque corporis est punctum quoddam intra positum, a quo si grave appensum mente concipiatur, dum fertur, quiescit; et servat eam, quam in principio habebat positionem, neque in ipsa latione circumvertitur"

[4] How was this fact justified? By Guidobaldo's second *Suppositio*, by Axiom IV of Archimedes's *Equilibrium of Planes* (the barycentres of congruent figures are situated similarly) or by the fourth theorem of the same work? In our opinion, there is no need to invoke Guidobaldo's second *Suppositio* in this situation, cf. footnote 2 on page 138. Also Guidobaldo seems to have been of this opinion: he does not refer to his second supposition in that prove, only in an aliter on fol. 6r. Correspondingly, he states in the "Letter to the Goth" (cf. Part B, I.4.4): "Anyway, I do not prove the fourth proposition of my *Mechanicorum Liber* basing me on the second supposition, as he says, but on the definition of the centre of gravity. So, it is clear how little the Goth understands; even if it is true, that I subsequently confirm this by a proof by contradiction having recourse to this supposition."

chanical systems as autonomous, unique physical entities with a definite barycentre.[1]

Guidobaldo's argumentation is the following: C is postulated to be the rotation point of the balance. If the device, with equal weights in A and B, is in the horizontal position, it is clear that the point C further is the centre of gravity of the whole system composed by the weights and the line linking their centres of gravity. And even if the balance is now moved in the inclined position DE, the point C remains the barycentre.[2]

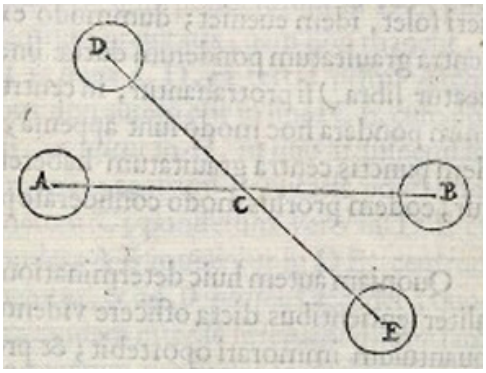

Figure IV.21: The isostatic balance in Proposition IV of the *Mechanicorum Liber*.

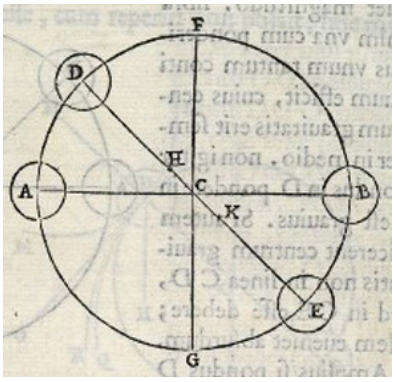

Figure IV.22: The figure illustrates two of Guidobaldo's objections to the concept *gravitas secundum situm*, applying the concept *centre of gravity* to the results predicted by the *Scientia de Ponderibus*.

Consequently, for Pappus' definition of *centre of gravity* the balance stays at rest in this inclined position which was to be proved. As mentioned above, Guidobaldo implicitly uses in this demonstration the supposition that he can treat the balance as an *unique* physical entity, despite of the fact that it is composed by *two* weights.[3]

[1]This aspect of Archimedean mechanics can be observed, for example, in the demonstration of the law of the lever for commensurable magnitudes, i.e. the sixth proposition of *On the Equilibrium of Planes*. This conceptual element should not be underestimated, as in other writers, for example in Jordanus or even Benedetti, such a theoretical identification does not take place.

[2] Does Guidobaldo implicitly use here the second *Suppositio*? In my opinion not – also in Guidobaldo's not: cf. footnote 4 on page 137. In fact, this step can also be motivated by Archimedes's forth proposition of the *Equilibrium of Planes*, which claims that the centre of gravity of a magnitude composed by to equal magnitudes is situated in the middle point of the line that links their centres of gravity. It is improbable that Archimedes referred only to bodies for which the line between their centres of gravity was horizontal.

[3]From this point of view, it is this what makes out the argumentative strength of the Archimedean concept *centre of gravity*: it allows to combine physical and geometrical properties.

After a short comment that this prove holds for material beams, too, Guidobaldo begins his long, long argumentation against the theories exposed by Jordanus, Cardano and Tartaglia who had argued against the possibility of indifferent equilibrium for the isostatic balance. He claims to intend to dwell "*aliquantulum*", i.e. a little bit, on this topic: a pure euphemism, given the 50 pages that are to follow about the topic demanding a great deal of concentration.

1. The direct prove of the existence of indifferent equilibrium (fol. 5r/v)
2. Incompatibility of the *gravitas secundum situm*-theory with the Archimedean mechanics (fol. 6r/v)
3. The convergence of the lines of action (fols. 6v-8r)
4. *Excursus*: The positional heaviness of a weight on a rotatable balance arm and the position variation of the point of highest positional heaviness depending on external parameters (fols. 8v-15r)
5. Intrinsic contradictions of Jordanus' theory and proposals for modifications to the *gravitas secundum situm* (fols. 15v-19r)
6. Converging versus parallel lines of action (fols. 19v-20v)
7. Against Cardano (fols. 20v-23r)
8. Defense of Aristotle's treatment of the balance with an excursus on balances of stable and unstable equilibrium (fols. 23r-28v)
9. Generalizations and conclusive considerations (fols. 28v-30r)

Figure IV.23: The argumentative structure of the digression after the fourth proposition.

The argumentation is divided in distinct levels, cf. figure IV.23. With this structure, Guidobaldo follows Aristotle as model, discussing and confuting his adversaries' arguments. We know about this intention from a letter he had sent to Pigafetta in occasion of the vulgar translation of the *Mechanicorum Liber*.[1] In

[1]Cf. BAM, fondo Pinelli, ms D 34inf, fols. 117r-119v: "(...) Ma acciocché questa sua nuova opinione dimostrata nella detta quarta propositione resti al tutto chiara, non si è contentato di averla dimostrata con vive ragioni, ma come scientifico (imitandolo Aristotele il quale nei principii dei suoi libri, volendo trovar miglior scienza, ha sempre dato contra l'opinione degli antichi, confutando le loro ragioni) ha voluto (essendo la verità una) scioglier le ragioni degl'altri, che par che provino il contrario, mostrando la loro fallacioa, facendo questa digressione che seguita che in questa materia servirà (come si suol dire) per l'opinion degl'antichi (...)." For a complete transcription of the letter, see Part B, I.4.1.

this context, he partly adopts even the principles used by his opponents, in order to show that their conclusions were wrong.

The incompatibility of Jordanus' theory with the Archimedean mechanics

Guidobaldo's first argumentative unit (fol. 6r/v) shows that Jordanus', Tartaglia's and Cardano's argumentation about the returning of the balance in the horizontal position is not compatible with the Archimedean concept of *centre of gravity* –[1] rigorously recurring to Archimedean theorems and concepts applied to central statements of the *Scientia de Ponderibus* in order to confute them:
As claimed by the medieval scholar, the weight in D is positionally heavier than the one in E (cf. figure IV.22). So, Guidobaldo deduces, the position of the centre of gravity of the system must have changed;[2] it must have moved to H, i.e. nearer to D,[3] compared to the "horizontal case" when the centre of gravity was C. And this is impossible as the weights maintain their distances regarding each other and the centre of gravity does not change position in regard to the body, according to the second supposition of the *Mechanicorum Liber*.[4] Guidobaldo explicitly emphasises that the balance with the attached weights has to be considered as *one, unique* physical body.[5]

In the second part of this first argumentative unit, Guidobaldo takes up an argument against Jordanus' *gravitas secundum situm* that must date at least from Tartaglia's time – the latter's virtual interlocutor Mendoza in the *Quesiti et Inventioni diverse* objected an argumentation similar to the one adopted by Guidobaldo here:[6] if we suppose that the weight in D has become positionally heavier, so a little additional weight in E is able to counterweight the weight in

[1]Cf. *Mechanicorum Liber*, fol. 6r: "Et quoniam in unam conveniunt sententiam, afferentes scilicet libram DE (...) in AB horizonti aequidistantem redire, hanc eorum sententiam nullo modo consistere posse ostendam."

[2]By doing so, he here ignores, probably willingly, the notion "positional heaviness", interpreting it as weight in an absolute sense.

[3]This can be deduced from the *Equilibrium of Planes*, Prop. III which reads (in the version of Guidobaldo's *Paraphrasis*: "Inaequalia gravia ex distantiis inaequalibus aequeponderabunt, maius quidem ex minori."

[4]Cf. *Mechanicorum Liber*, fol. 6r: "Quoniam autem centrum gravitatis ponderum in AB connexorum est punctum C, ponderum vero in DE est punctum H, dum igitur pondera AB moventur in DE, centrum gravitatis C versus D movebitur et ad D propius accedet: quod est impossibile, cum pondera eandem inter sese servent distantiam. Uniuscuiusque enim corporis centrum gravitatis in eodem semper est situ respectu sui corporis [2. Sup.<positio> huius <libri>]"

[5]Cf. *Mechanicorum Liber*, fol. 6r/v: "Ideo punctum C ita eorum erit centrum gravitatis, ac si una tantum // esset magnitudo. Libra enim una cum ponderibus unum tantum continuum efficit, cuius centrum gravitatis erit semper in medio."

[6]For further information on Tartaglia's *Quesiti et Inventioni diverse*, cf. Part A, III.5.

D, so that the balance, held in C, stays at rest (cf. figure IV.22).[1] Since the weights in D and E were, though, supposed to be *absolutely* equal, the additional weight in E would displace the centre of gravity from C to K, i.e. nearer to E, and therefore, the balance will stay at rest if and only if it is held in K. This is a contradiction to the hypothesis that it is at rest when held in C, for a body cannot have two centres of gravity (*Suppositio* I^2 of the *Mechanicorum Liber*).[3]

The convergence of the lines of action

Guidobaldo now exposes Tartaglia's reply against the just exposed objection,[4] and introduces, while arguing against Tartaglia's reply, the idea of the convergence of the lines of action (fols. 6v-7v). The author of the *Quesiti et Inventioni diverse* had explained that the proportion between the positionally heavier weight in D and the weight in E is smaller than any finite proportion.[5] The reason for this would be the fact that the angles of descent – in Jordanus' and Tartaglia's theory the measure of the positional weight – differed only about an curvilinear angle which is infinitely smaller than any rectilinear angle.
Guidobaldo agrees that the curvilinear angle MDG (cf. figure IV.24) is smaller than any rectilinear angle. Yet, he retorts that there are nevertheless smaller angles than the angle MDG, for example MDO, i.e. its bisection. At the end of a page dedicated to a lesson on geometrical ways of angle-division (f.7v), he concludes that one cannot ever speak of a "minimal" angle. This is relevant for the argumentation since Tartaglia had claimed that the proportion between the two weights is minimal – exactly because the difference of their virtual descents, i.e. the difference of the descent angles, would be minimal.[6]
It is now that Guidobaldo adduces – in order to counter Tartaglia's reply (!) – the argument that in modern historiography of mechanics has often been (mis)used to claim that the Marchigian mathematician has been unable to discern relevant

[1] Cf. *Mechanicorum Liber*, fol. 6v: "Adiiciatur ergo ponderi E aliquod grave, ita ut ipsi D contraponderet, si ex C suspendantur."

[2] Cf. *Mechanicorum Liber*, fol. 1v: "SUPPOSITIONES I. Unius corporis unum tantum est centrum gravitatis."

[3] Cf. *Mechanicorum Liber*, fol. 6v: "Erit centrum gravitatis in linea CE; sitque hoc centrum K. At per definitionem centri gravitatis, si pondera suspendantur ex K, manebunt. Ergo si suspendantur ex C, non manebunt, quod es contra hypotesim. (...) Quodsi ex C quoque suspensa aequeponderarent, unius magnitudinis duo essent centra gravitatis, quod est impossibile [1. Suppos. huius <libri>]."

[4] Mendoza had adduced the same objection in a similar form – without, yet, making use of the concept *centre of gravity*.

[5] For further information on Tartaglia's argumentation, cf. Part A, III.5.

[6] *Mechanicorum Liber*, fol. 7v: "Atque ideo proportionem ponderis in D ad pondus in E non adeo minorem esse sequitur, quia ad infinitum ipsa semper minorem reperiri possit; et qui angulus MDG in infinitum dividi potest, excessus quoque gravitatis D supra E dividi ad infinitum poterit."

physical facts and phenomena from irrelevant ones:[1] the convergence of the lines of action of the weights fixed in E and D (cf. figure IV.25).[2]

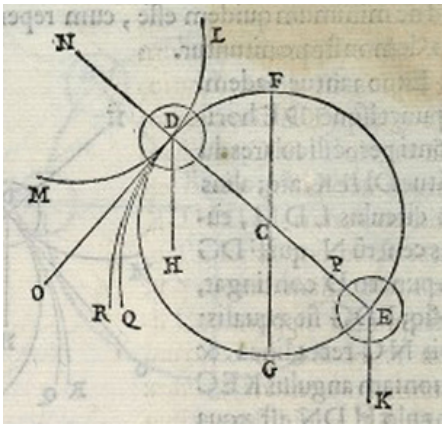

Figure IV.24: The figure illustrating Tartaglia's reasoning. Guidobaldo shows that the angle MDG is not minimal.

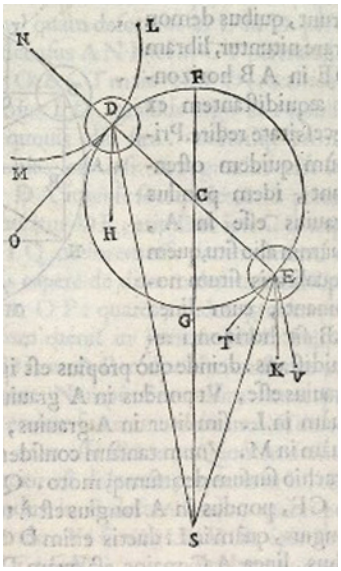

Figure IV.25: The consideration of convergent lines of action.

Guidobaldo shows (fol. 8r) that, considering *convergent* lines of action, i.e. DS and ES instead of the parallel ones DH and EK, the angle SDG is bigger than SEG. Since these two "angles of descent" measure the positional heaviness of the weights D and E, the descent of the weight in D "in reality" is more oblique than

[1]The problem of such presentations is that they do not take into consideration the context in which Guidobaldo expressed the convergence of the lines of action. A more detailed analysis of Guidobaldo's use of convergent and parallel lines is exposed in Part A, IV.2.3.

[2]Now, if one really thinks that this was Guidobaldo's conviction and not an argument *ad hominem*, one would not be completely mistaken claiming that Guidobaldo was too precise and nitpicker in considering *convergent* lines of force. Yet, at least he avoids the argumentative *zig-zag* we have seen in Jordanus, Tartaglia and Benedetti!! These, according to what they wanted to prove, used one or the other possibility – without any consideration of conceptual coherency – Guidobaldo did not.
Further, as Tartaglia adduces an argument that recurred to minimal quantities like curvilinear angles – which are smaller than any given finite, rectilinear angle. So why should not Guidobaldo have considered equally minimal differences between parallel and convergent lines of action?
One might wonder why Benedetti first assumed parallel lines of action in the first two propositions, and then in Caput VII converging ones, criticising Tartaglia and Jordanus for their consideration of *parallel* lines of action. A similar critique could be made towards Tartaglia which speaks of convergence of the lines of action but then treats them as parallel, or to Jordanus.
In fact, the only one who reaches a satisfying compromise between parallel and converging lines of action is Guidobaldo.

the one of E. So, according to Jordanus' and Tartaglia's own *gravitas secundum situm*-theory, the weight in D would not be positionally heavier, but, in contrast, lighter than the one in E.[1]
Dal Monte explicitly claims that it was by his opponents that the argument of the convergence of the lines of action was adduced.[2] And with this statement he is right.[3]
If this argument of Guidobaldo's about the convergence of the lines of action served only as *argumentatio ad hominem*[4] or if it *really* was Guidobaldo's belief that this fact should be taken into account for a mathematical-physical analysis, is a question that cannot easily answered: there are arguments for both possibilities, cf. Part A, IV.2.3.

Which inclination makes a weight on a rotatable balance arm heaviest?

Then (f.8v-11v), Guidobaldo comes to speak about several arguments according to which a weight, considered singularly, is positionally most heavy in O (Guidobaldo's position) or in A (according to Jordanus[5] and Cardano[6]), cf. figure IV.26. Cardano had introduced the argument into the debate that the same weight is positionally most heavy in A (cf. figure IV.27) because the nearer it

[1] *Mechanicorum Liber*, fol. 8r: "Auferatur ab angulo SDM angulus curvilineus MDG; ab angulo autem VEG angulus auferatur VES. Et angulus VES rectilineus maior est curvilineo MDG; erit relinquus angulus SEG minor angulo SDG. Quare ex ipsorum suppositionibus non solum pondus in D gravius erit pondere in E. Verum e converso, pondus in E ipso D gravius existet."

[2] *Mechanicorum Liber*, fol. 8r: "Quoniam autem (ut ipsi quoque supponunt) lineae DH, EK in centrum mundi conveniunt, lineae DH, EK aequidistantes nunquam erunt et angulus KEG angulo HDG non solum maior erit, sed minor."

[3] In effect, Jordanus postulates in the first axiom of the *Elementa* that "the motion of every weight is toward the center (of the world)" ("Omnis ponderosi motum esse ad medium." The same postulate is adduced also in *De ponderibus* and *De ratione ponderis*; cf. Moody&Clagett, *The Medieval Science of Weights*, cit.). Tartaglia paradoxically claims to draw "two straight lines (..) perpendicular <to the horizon>, towards the centre of the world" (*Questioni et Inventioni diverse*, fol. 91: "Tiro le due rette linee *ah* et *bd* perpendicolare verso il centro del mondo."). Also Benedetti, eight years after the first edition of the *Mechanicorum Liber* used a similar argumentative *zig-zag* about *parallel* lines which form an angle smaller than 180 degrees... (*Diversarum Speculationum Liber*, p. 142: Benedetti speaks about an filament FU which coincides with the line of action: "Ad cuius rei evidentiam imaginemur filum FU perpendiculare", or "si imaginemur filum appensum ipsi u brachii BC et usque ad e perpendicularem.". Then, though, Benedetti states (p. 143) that the angle between axis and the horizontal is not right: "unde angulus CBQ fiut ut minor sit recto", differing about an "angulus insensibilis" from the right angle...).

[4] I.e. an argument simply used because it was Tartaglia to bring it into play and because it helped Guidobaldo to confute the former's theory, even without his substantial agreement

[5] Cf. *Elementa*, Prop. IV.: "Quodlibet pondus, in quamcumque partem ab equalitate discedat, secundum situm fit levius."

[6] *De Subtilitate*, p. 27: "Dico quod pondus in C constitutum erit gravius quam si lanx collocetur in quocumque alio loco (...)."

is to the vertical axis CF, the lighter it becomes. Jordanus had held a similar view about the most effective heaviness of the weight in A, attributing this, though, to the more vertical motion from A than in other points.[1] After this review, the Marchigian mathematician goes about confuting these arguments on the following pages.[2]

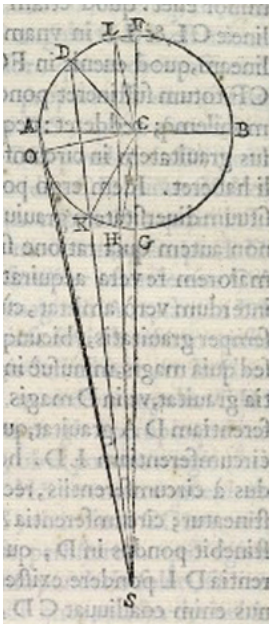

Figure IV.26: Guidobaldo argues that a weight on a rotatable balance arm is positionally heaviest in O, recurring also here to the convergence of the lines of action.

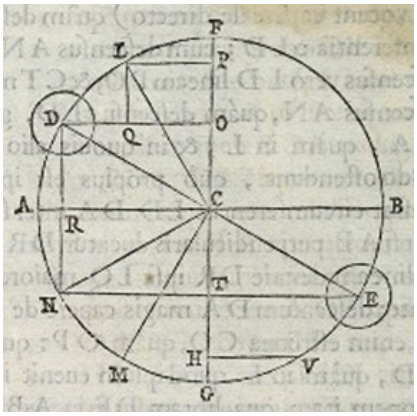

Figure IV.27: According to Cardano, the horizontal projection from the position of the weight to the vertical axis is the measure of the positional heaviness of the weight.

Guidobaldo does not negate that, according to the inclination of the rotatable beam with the fixed weight, its effective heaviness does vary. But he adduces other reasons than the *gravitas secundum situm*, substantially two different ones: first, the resting of the weight upon the beam and consequently on the centre C. Secondly, the vicinity of the weight's actual way of descent to the path of natural descent:

In order to prove his two arguments, Guidobaldo again takes up the idea of converging lines of action (f.10r). The vertical axis of the circle described by the rotatable balance arm is prolonged to the centre of the world S (cf. figure IV.26).

[1] Cardano substantially repeats this reasoning of Jordanus as second motivation for the highest positional heaviness of the weight. For further information on Cardano's occupation with mechanics, cf. Part A, III.5.

[2] *Mechanicorum Liber*, fol. 9r: "His itaque rationibus conantur ostendere libram DE in AB redire, quae meo quidem iuditio facile solui possunt. (...)"

From there, he then draws the tangent to the circle with contact point in O, somewhat below A. Moreover, he chooses other arbitrary points D and L on the circumference and connects them with S. Now, the effective heaviness, according to Guidobaldo, is determined by the measure by which the weight differs in its actual descent along the circumference from the line towards the centre of the earth, i.e. from its path of natural descent: so, if the weight is situated in L, the beam LC is "rather near" to the natural line of descent LS, whence the weight in L rests in a high measure upon the beam and the centre C. Consequently, its effective weight is rather light. The same weight in D rests less upon the beam DC and is, thus, positionally heavier – the angle SLC is smaller than CDS.[1]
So, Guidobaldo agrees that the effective heaviness of a weight varies depending on the inclination of the beam on with the body is fixed.[2] But this is not caused by the *gravitas secundum situm*, but is due to the fact that the measure varies by which the weight rests upon the beam and the centre of rotation C.[3]
Also regarding the difference of the paths of descent, the result is confirmed: the mixed angle SLD is bigger than SDA (fol. 11r),[4] therefore the descend of the weight in D is nearer to its *motus naturalis* (in the virtual case that it were not fixed to the beam), than it is the descent of the weight in L to its own line LS of natural descent. Thus, the weight in D is "freer" than the one in L, moves in a more natural way and thus is heavier in L.[5]
If the weight is situated in O (f.11v), so its descent along the circumference cannot be nearer to its natural line of descent, being OS the tangent from S to the circumference. Moreover, according to Guidobaldo's first reasoning, the beam CO does not hold any part of the body in O, as the angle between CO and OS is right.[6] Therefore, Guidobaldo concludes this counter-argument that the

[1] *Mechanicorum Liber*, fol. 10r: "Pondus in L magis supra lineam CL gravitabit quam existens in D supra lineam DC. Ergo lineo CL pondus magis sustentabit quam linea CD. Eodemque modo, quo pondus propius fuerit ipsi F, magis ob hanc causam a linea CL sustineri ostendetur."

[2] *Mechanicorum Liber*, fol. 10v: "Idem ergo pondus propter situum diversitatem gravius leviusque erit. Non autem qui ratione situs interdum maiorem re vera acquirat gravitatem, interdum vero amittat, cum eiusdem sit semper gravitatis, ubicunque reperiatur, sed quia magis, minusve in circumferentia gravitat, ut in D magis supra circumferentiam DA gravitat, quam in L suptra circumferentiam LD."

[3] In this we could identify a certain analogy to a principal idea of the *Quaestiones Mechanicae*: also according to Aristotle, the effective heaviness of a weight is influenced by its interaction with the beam (*Quaestio* I). This would be the reason, why the same weight on a shorter balance arm has a lower effective heaviness than on a longer arm, as the weight is forced to a unnatural motion by the beam.

[4] Guidobaldo proves this geometrically, but we do not report the demonstration.

[5] *Mechanicorum Liber*, fol. 11r: "Pondusque magis liberum erit in D quam in L: cum pondus naturaliter magis per DA moveatur quam per LD, quare gravius erit in D quam in L."

[6] *Mechanicorum Liber*, fol. 11v: "Erit descensus ponderis in O motui naturali ipsius ponderis in O soluti propior, quam in alio situ circumferentiae OKG; lineaque CO minus pondus sustinebit quam si pondus in quovis alio fuerit situ eiusdem circumferentiae OG. Similiter (...)

same weight, considered singularly, is positionally most heavy in O, i.e. in the contact point of the tangent from the centre of the world to the circumference, and not in A.[1]

The question about the varying positional heaviness of the weight on the circumference continues to occupy Guidobaldo for the next pages (fols. 12r-15r). First, Guidobaldo motivates the fact that a weight is positionally heavier on a longer balance arm with the fact that its path of forced descent along the bigger circumference is closer to the path of natural descent.[2]

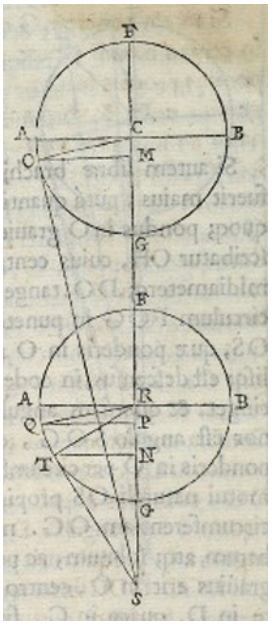

Figure IV.28: The variation of the position of the contact point O (and T in the second case).

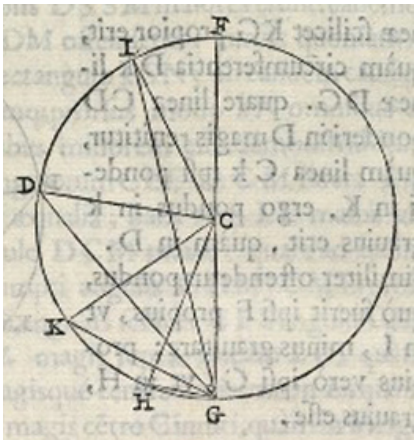

Figure IV.29: This figure illustrates the case in which the lowest point of the circumference G coincides with the centre of the world. So the lines of action of the weights in L, D, K and H terminate in G.

While Guidobaldo, on the pages before, had proved that the weight is heaviest in the contact point between tangent and circumference, he now shows that the position of this point is varying with the position between the circumference of the balance and the centre of the world (cf. figure IV.28).

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erit descensus ponderis in O soluti propior quam in alio situ circumferentiae ODF. Praeterea quoniam linea CO pondus in O dum deorsum movetur, impellere non potest, ita ut ultra lineam OS circulum non s ecet, sed contingat, angulusque SOC sit rectus et non acutus. (...) Erit igitur pondus in O magis ob has causas liberum, atque solutum in hoc situ, quam in quovis alio circumferentiae FOG."

[1] *Mechanicorum Liber*, fol. 11v: "Ac idcirco in hoc <situ O> gravius erit, hoc est magis gravitabit quam in alio situ, et quo propius fuerit ipsi O remotiori gravius erit."

[2] Interestingly, Guidobaldo here does *not* consider a converging, but a perpendicular line of action.

For this purpose, Guidobaldo first evidences that the nearer the circumference is situated to the centre of the world, the farer its contact point with the tangent is from A, i.e. from the intersection of the circumference with the horizontal line.[1] Then, he analyses the case in which the lowest point of the circumference G coincides with the centre of the earth (figure IV.29): in this case, the nearer the weight is to the centre of the world G, the heavier it is positionally: but the beam always partly depends from or rests upon the centre of the circumference C, as the angle CKG cannot ever become right for this case.[2]

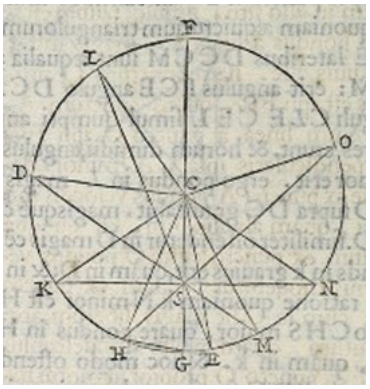

Figure IV.30: Guidobaldo here considers the case in which the centre of the world is situated between the centre of the circle and its lowest point G.

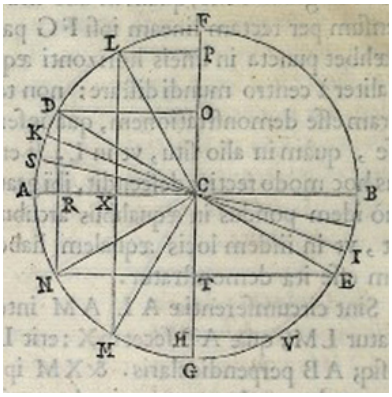

Figure IV.31: Guidobaldo evidences a conceptual weakness of the *gravitas secundum situm*-theory, considering the descent from a weight from D to A once piecewise, and then as a whole.

Next, Guidobaldo examines the case in which the centre of the earth S is situated between C and G (cf. figure IV.30), and after this with the case in which the centre of the circle coincides with the centre of the world (cf. again figure IV.30). Guidobaldo concludes this argumentative unit stating that the falsity of his adversaries' claim is proved: neither the weight is positionally most heavy in A (cf. figure IV.26), nor the nearer the weight is to the vertical axis FG the heavier it is positionally (since O, e.g., is nearer to it than A). Further, even the claim

[1]There is no need to underline that Guidobaldo shows all these arguments with a perfect, geometrical rigour, exactly citing in marginal notes the adopted proposition of the *Elements*.

[2]Cf. *Mechanicorum Liber*, fol. 13r/v: "Aequicruris enim trianguli CKG ad basim anguli ad K et G sunt semper acuti. (...) Magis igitur sustinebit linea CD quam CK, ac propterea pondus in K ex superius dictis gravius erit quam in D. (...) Linea CK pondus partim sustinebit, ipsique renitetur, cum illud per circumferentiam KH moveri compellat. (...) Circumferentia igitur KH motui naturali ponderi in K soluti, li//neae scilicet KG propior erit, quam circumferentia DK lineae DG, quare linea CD ponderi in D magis renititur quam linea CK ipsi ponderi in K. Ergo pondus in K gravius erit quam in D. Similiter ostendetur pondus quo fuerit ipsi F propius, ut in L, minus gravitare; proprius vero ipsi G, ut in H gravius esse."

that the weight moves fastest in A is wrong: its movement is fastest in O, as its movement is most free in O, not in A, and its path of descent nearest to the natural path of descent.[1]

Intrinsic contradictions of Jordanus's theory

Now, Guidobaldo enters a new level of argumentation (fols. 15v-19r): even if one conceded that the weight is positionally most heavy in A or that the lines of action parallel, Jordanus, Tartaglia and Cardano would not be right;[2] Guidobaldo goes about dismantling another element of Jordanus' theory: according to the latter's principles, weights whose (possibly also virtual) descents cover the same vertical component along the same arc, are equally heavy positionally. For example (cf. figure IV.31), for equal arcs LA, AM the vertical components of the descents from L in A and from A in M are equal. Therefore equal weights would have to have the same positional heaviness in L and A -[3] a clear contradiction even to what those have claimed elsewhere.
Now, Guidobaldo confutes hypothetical objections of his adversaries that are not even contained in their writings: in fact, one could object that L and A nevertheless are not of equally heavy *secundum situm*: the weight in A would in effect be heavier since the beginning of its descent is more vertical than the one of the weight in L. But if this were true so the *gravitas secundum situm* would not be a well-defined concept, as Guidobaldo points out: the same weight in the same position would present different positional heavinesses, as the positional heaviness would vary according to the point the weight would descend. If we consider e.g. the weight in L, it would be heavier when it descends until A, and

[1] Cf. *Mechanicorum Liber*, fol. 15r: "Ex dictis igitur, considerando libram, ut longe a mundi centro abest, quemadmodum ipsi fecere, sicuti etiam actu est, apparet falsitas dicentium pondus in A gravius esse quam in alio situ. Simulque falsum esse, quo pondus a linea FG magis distat gravius esse. Nam punctum O proprius est ipsi FG quam punctum A. (...) Deinde, es puncto A pondus velocius moveri, quam ab alio situ, est quoque falsum. Ex puncto enim O pondus velocius movebitur quam es puncto A, cum in O sit magis liberum atque solutum, quam in alio situ; descensusque ex puncto O propio sit motui naturali recto, quam quilibet alius descensus."

[2] Cf. *Mechanicorum Liber*, fols. 15v-16r: "Concedamus etiam pon//dus in A gravius esse, quam in alio situ; rectumque ponderis descensum per rectam lineam ipsi FG parallelam fieri debere. Et quaelibet puncta in lineis horizonti aequidistantibus accepta aequaliter a centro mundi distare: Non tamen propterea sequetur, veram esse demonstrationem, qua inferunt pondus in A gravius esse quam in alio situ, ut in L. Si enim verum esset, quo pondus hoc modo rectius descendit, ibi gravius esse, sequeretur etiam, quo idem pondus in aequalibus arcubus aequaliter recte descenderet, ut in iisdem locis aequalem haberet gravitatem. Quod falsum esse ita demonstratur. (...)"

[3] This can be deduced from the Axioms III-V of *De ratione Ponderis*: "III. Gravius esse in descendendo, quanto eiusdem motus ad medium rectior. IV. Secundum situm gravius esse, cuius in eodem situ minus obliquus descensus. V. Obliquiorem autem descensum, in eadem quantitate minus capere de directo." Cf. Moody&Clagett, *The Medieval Science of Weights*, cit.

less heavy if it would go only until D. Obviously, such a conceptional ambiguity is not acceptable for a physical concept.[1]
The same problem appears if we return to consider the inclined isostatic balance in DE: if we take into consideration the descents along the entire arcs DA and AN, the two weights are of equal positional heaviness. Yet, if we imagine the descent of the weight in singular steps, i.e. first from D to K, then to S to A,[2], so it is clear that the weight is positionally heavier in K as in D, in S heavier than in K, and in A not lighter than in S. So, *summa summarum*, in this way of consideration it is heavier in A than in D, in contradiction to the first consideration.[3]

Not only due to this absurdity, Guidobaldo again emphasises that the *gravitas secundum situm* is not an acceptable mechanical concept. And, as if this had not been enough, one can even show that the weight with the more oblique descent is the positionally heavier one, i.e. another intrinsic contradiction of the concept *gravitas secundum situm* (fols. 17r-18r; cf. figure IV.32):
Guidobaldo proves that the vertical component of the descent of a weight from L to A is bigger than the one of the descent of the same weight along the arch OP of the same length. Thus, according to the *gravitas secundum situm*, the weight in L would be positionally heavier than in O – in contradiction to Cardano's and Jordanus' claims that the closer a weight is the horizontal axis the heavier it is positionally.
In order to prove this, Guidobaldo takes equal arcs LA, AM, where L is close to F. Now, he takes a point P between M and P and determines O so that OP is equal to the arch AM. Then, he links the centre of the circumference C with the points L, O, M, P and O with P. Hence, he draws from C the perpendicular PN to OC. Through easy geometrical considerations he finds that the triangles MCX and PCN are equal, so NP is equal to MX (which is equal to XL).
He then draws the parallel OT to AC, and equally its perpendicular PT; the latter is the vertical measure of the descent from O to P. Another easy geometrical consideration evidences that PT is not falling between OV, where V is the intersection of OT with PN. Further, it can easily be shown that OT is longer than ON. As the triangles ONP, OTP are right-angled, the square of OP is

[1] *Mechanicorum Liber*, fol. 16r: "Ideo pondus gravius erit in A quam in L: quod si verum esset, sequeretur idem pondus in eodem situ diverso duntaxat modo consideratum in habitudine ad eundem situm, tum gravius, tum levius esse, quod es impossibile. Hoc est, si descensum consideremus ponderis in L, quatenus ex L in A descendit, gravius erit quam si eiusdem ponderis descensum consideremus ex L in D tantum."

[2] These arches are supposed to be equal.

[3] Cf. *Mechanicorum Liber*, fols. 16v-17r: "Atque ita, si aequales descensus DA, AN invicem comparemus, qui aequaliter de directo capient OC, CT, eveniet idem pondus in D aeque grave esse ut in A. Si vero portiones tantum ex DA accipiamus, gravius erit in A quam in D. Ergo ex diversitate tantum modi considerandi, idem pondus et gravius et levius esse continget, non autem ex ipsa na//tura rei."

equal both to the sum of the squares ON and NP as well as to the sum of the squares OT and TP. Now, since OT was bigger than ON (and the same is valid for their squares), is follows that PN is bigger than TP. As PN is equal to MX and to XL, this means that the vertical measure of the descent of the weight from L to A, i.e. LX or NP, is bigger than the vertical measure of the descent of the weight from O to P, i.e. TP. Therefore, the weight in L is positionally heavier than the weight in O, as Guidobaldo wanted to show, in contradiction to Jordanus and co.'s claim that the weights near to A are positionally heavier than the ones farer from it.

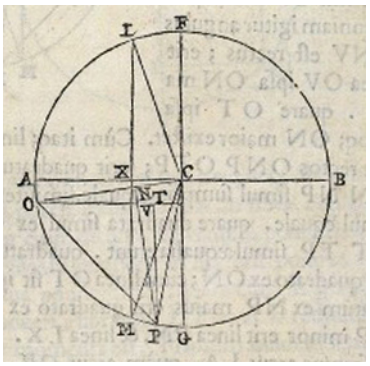

Figure IV.32: Guidobaldo shows that the descent of a weight from L to A is less oblique than from O to P. So, according to the *gravitas secundum situm*, the weight would be heavier in L than O. This is in contradiction to the statement that weights near to A are positionally heavier than those far from it.

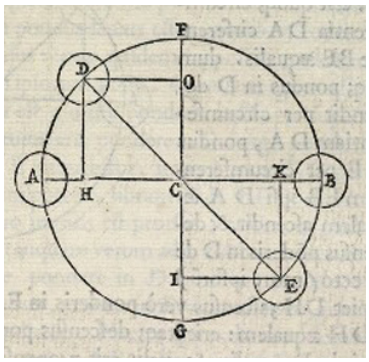

Figure IV.33: Guidobaldo suggests possible modifications to the *gravitas secundum situm*-theory. One of them is to compare the descent of one weight with the *ascent* of the other.

Guidobaldo concludes with the appeal, that the more or less vertical descent cannot hence be the measure of the positional heaviness of a weight. And even if some of his adversaries' assertions were true, this would not change the fact that the foundation *gravitas secundum situm* would be absolutely useless and wrong.[1]

[1] *Mechanicorum Liber*, fol. 17v: "Ergo pondus in L, ex ipsorum dictis, gravius erit quam in O. Quod ex iis, quae supra diximus est manifeste falsum, cum pondus in O gravius sit, quam in L. Non igitur ex rectiori et obliquiori motu ita accepto colligi potest, scundum situm pondus gravius esse, quanto in eodem situ minus obliquus est descensus. Atque hinc oritur omnis ferme ipsorum error in hac re, atque deceptio: nam quamvis per accidens interdum ex falsis sequatur verum, per se tamen ex falsis falsum sequitur, quemadmodum ex veris semper verum, nil idcicro mirum, si dum falsa accipiunt, illisque tanquam verissimis innituntur, falsissima omnino colligunt, etque concludunt."

In the following, Guidobaldo approaches an in his eyes central problem of the treatment of the balance in the *Scientia de Ponderibus* (fols. 18r-19r): when it deals with the isostatic balance, the weights attached to the latter are always considered *autonomously*: in fact, the descent of one weight is compared with the *descent* of the other one. Yet, according to Guidobaldo, as the weights are connected by the balance, the descent of the first body has to be compared with the *ascent* of the second one.[1]

In order understand Guidobaldo's concern, it is convenient to keep in our mind the following fact: To us, that we have a conception about potential energy, the idea of the *gravitas secundum situm*-theory to consider the descents of *both* weights as measures for their heaviness might seem somewhat "normal" (-> "virtual work"). For Guidobaldo, instead, the consideration of two descents must have appeared rather arbitrary, surely not justified: and so he goes about to evidence this arbitrariness with the considerations of this section, about one descent and one ascent (so the isostatic balance remains at rest in the inclined position) and about two ascents (the isostatic balance goes in the vertical position).

In fact, if the followers of the *Scientia de Ponderibus* considered one descent and one ascent, they would comprehend that the weights stay at rest in the inclined position: the vertical measure of the descent of the weight from D to A is DH, while the measure of the ascent of the weight from E to B is EK (cf. figure IV.33). Elementary geometrical considerations show that they are equal, as also the arcs AD and EB are equal. This means that the *propensio* of the upper weight to descend is identical with the *resistentia* of the lower one to move upwards.[2] So the faster the weight in D sinks down according to the "natural force", the slower the weight in E ascents *violenter*. Thus, no weight will move, as for a movement it would be necessary that one weight would have a major *virtus* than the other – but the *virtutes* are equal, as we have just seen.[3]

[1] *Mechanicorum Liber*, fol. 18r: "Semper enim alterum pondus seorsum accipiunt, puta D vel E, ac si modo unum modo alterum in libra consitutum esset, nec ullo modo ambo connexa; cuius tamen oppositum omnino fieri oportet, neque alterum sine altero recte considerari potest, cum de ipsis in libra constitutis sermo habeatur. (...) Primum quidem semper argumentantur, ac si pondera in D, E descendere debeant, unius tantum sine alterius connexione considerando descensum. (...)"

[2] The resistance of a heavy body against a movement upwards is formulated in the first proposition of Jordanus' *Elementa*: "Inter quaelibet gravia est velocitatis in descendendo et ponderis eodem ordine sumpta proportio; descensus autem et contrarii motus proportio eadem sed permutata."

[3] Cf. *Mechanicorum Liber*, fol. 18v: "Erit itaque descensus ponderis in D ascensui ponderis in E aequalis. Et qualis erit propensio unius ad motum deorsum, talis etiam erit resistentia alterius ad motum sursum. Resistentia scilicet violentiae ponderis in E in ascensu naturali potentiae ponderis in D in descensu contranitendo apponitur, cum sit ipsi aequalis. Quo enim pondus in D naturali potentia deorsum velocius descendit, eo tardius pondus in E violenter ascendit. Quare neatrum ipsorum alteri praeponderabit, cum ab aequali non proveniat actio. Non igitur pondus in D pondus in E sursum movebit. Si enim moveret, necesse esset, pondus in D maiorem havere virtutem descndendo, quam pondus in E ascendendo: sed haec sunt

Also the distances from the vertical axis FG of the weights, respectively DO and IE are equal. So, if one wanted to measure the positional heaviness of the weights according to their *horizontal* distance from the axis – as for example Cardano does – so the weights would again turn out to be equally heavy.
With yet another modification to the *gravitas secundum situm*-theory, Guidobaldo tries to show another time the absurdity of the concept in question: in fact, one could also show that inclined isostatic balance moves to the vertical position. If Jordanus and co. consider the descents of every weight in order to get information about the virtual movement of the balance, so, Guidobaldo asks, why should it be prohibited to take into account, in contrast, the *ascents* of *both* weights? In this case, if we suppose to be positionally lighter the weight with a more oblique ascent, so the ascent of the weight in D would be less straight than the ascent of the weight in E; consequently, D would positionally lighter than E, and the balance would move in the vertical position FG. But this, too, is an useless reasoning, as the isostatic balance does not neither go upwards nor downwards in its inclined position.[1]

Converging *versus* parallel lines of action

On the following pages (fols. 19v-20v), Guidobaldo turns to the topic of parallel vs. convergent lines of action: if we again consider the isostatic balance in the inclined position DE (cf. figure IV.34), there is no doubt that the weight in D, if it were able to move freely, would fall along DS, where S is the centre of the world, and the weight in E analogously along ES.[2]
Yet, this is the property of the weights considered *autonomously*: if we instead consider the two weights attached to the balance, so it is misleading to take into consideration the paths of descent of the *single* weights. Rather, the connection with the other weight causes that their natural paths of descent are no longer ES and DS, but EK and DH.[3] In fact, C is the centre of gravity of the magnitude

aequalis, ergo pondera manebunt et gravitas ponderis in D gravitati ponderis in E aequalis erit."

[1]Cf. *Mechanicorum Liber*, fol. 19r: "Supponatur ergo secundum situm pondus levius esse, quanto in eodem situ minus rectus est ascensus: quae quidem suppositio, adeo manifesta esse videtur, veluti ipsorum altera. Quoniam igitur ascensus ponderis in E rectior est ascensu ponderis in D, per suppositionem pondus in D levius erit pondere in E. Ergo pondus in D sursum a pondere in E movebitur, ita ut libra in FG moveri. Quae quidem demonstratio inutilis est prorsus, easdemque patitur difficultates, licet enim tanquam verum admittatur pondus in E ascendendo gravius esse pondere in D similiter ascendendo, non tamen ex hoc sequitur, pondus in E descendendo gravius esse pondere in D ascendendo."

[2]Guidobaldo is not *a priori* against the idea to measure a more or less oblique descent of the weights, as long as the lines of reference are DS and ES.

[3]Cf. *Mechanicorum Liber*, fol. 19v: "Quibus respondemus plurimum referre, sive consideremus pondera, quatenus sunt invicem disiuncta, sive quatenus sunt sibi invicem connexa. Alia est enum ration ponderis in E sine connexione ponderis in D, alia vero eiusdem alteri ponderi connexi; ita ut alterum sine altero moveri non possit. Nam ponderis in E, quatenus est

composed by D, E and has the *propensio* to unify with the centre of the world – the movement follows the straight line CS if there are not obstacles. As the geometrics of the balance remain unvaried, the balance HK will be parallel to DE, with its centre of gravity once arrived in the centre of the world.

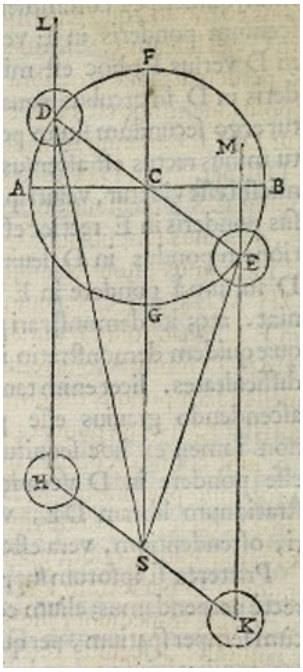

Figure IV.34: Guidobaldo's compromise between the Aristotelian idea of converging lines of action and the Archimedean conception of parallel ones.

So the lines of action themselves are changed by the circumstance that the respective weights are not unconnected but fixed to each other, due to the balance. Thus, this mechanical device effects that the *naturalis propensio* of the weight in E runs along MEK (cf. figure IV.34), and not any longer along ES: the gravity of the other weight in D causes that the gravity of the weight in E acts along EK, not ES.[1]
When we apply this reasoning to the problem of the inclined isostatic balance, so the descent of the weight from E in G is equally oblique (regarding to the line of its *natural* descent EK) compared to the *ascent* of the weight from D to

sine alterius ponderis connexione, rectus naturalis descensus est per lineam ES; quatenus vero connexum est ponderi in D, eius naturalis descensus non erit amplius per lineam ES, sed per lineam ipsi CS parallelam."

[1] *Mechanicorum Liber*, fol. 19v: "Si vero pondera in ED sibi invicem connexa, quatenusque sunt connexa consideraverimus, erit ponderis in E naturalis propensio per lineam MEK: gravitas enim alterius ponderis in D efficit, ne pondus in E per lineam ES gravitet, sed per EK. Quod ipsum quoque gravitas ponderis in E efficit, ne scilicet pondus in D per rectam DS degravet, sed secundum DH: utraque enim se impediunt, ne ad propria loca permeent."

F. Thus, the *propensio* of the weight in E to move downwards is equal to the *resistentia* of the other weight against a movement upwards, so there will not be movement at all.[1]

Against Cardano

In the following thematic unit (fols. 20v-23r), Guidobaldo approaches the confutation of another argument for the return of the inclined isostatic balance in the horizontal position. Cardano had claimed that CF was the *trutina*, i.e. the suspension arrangement, and CG, in contrast, the *meta*, i.e. the "goal" of the inclined balance (cf. figure IV.35). As the angle DCG is major than ECG, the weight in D would be positionally heavier than the one in E he had claimed without any other explication.[2]

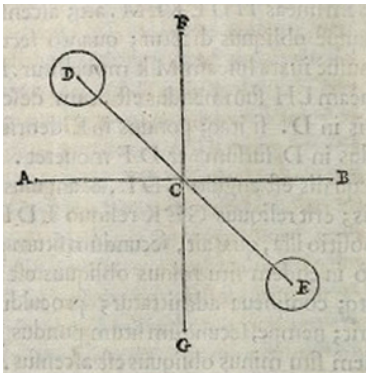

Figure IV.35: If we call "*trutina*" the half of the vertical axis FG where the balance is fixed, and "*meta*" the other, so Cardano claims that the angle formed by the beam and the *meta* is the measure of the positional heaviness of the respective weight.

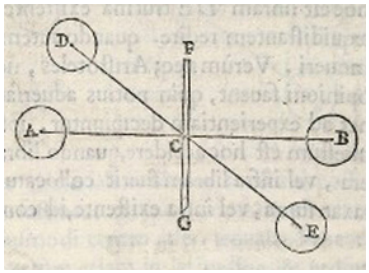

Figure IV.36: Cardano's argument seems rather absurd to Guidobaldo. So he asks what would happen for a balance with a supporting device from F to G. In this case, *trutina* and *meta* would coincide...

This curious argument seems so absurd to Guidobaldo that he claims not to intend to spend not even a word about it. He rhetorically asks why the angle GCD should be the measure of the gravity and not, for example, FCE (cf. figure IV.36)?[3]

[1] Cf. *Mechanicorum Liber*, fol. 20v: "Eandem enim obliquitatem habet descensus ponderis in E, quam habet ascensus ponderis in D; et qualis erit propensio unius ad motum deorsum, talis quoque erit resistentia alterius ad motum sursum. Non ergo pondus in E pondus in D sursum movebit, neque pondus in D deorsum movebitur, ita ut sursum moveat pondus in E."

[2] For further information on Cardano's occupation with mechanics, cf. Part A, III.5.

[3] Cf. *Mechanicorum Liber*, fols. 20v-21r: "Nihil meo iudicio concludit. Figmentumque hoc

And yet, Guidobaldo cannot nevertheless overcome the temptation to adduce a counter-argument: if we consider a balance like the one in figure IV.36, which is held by the whole segment FG, so what is now the *trutina* and, consequently, which is now the angle that counts? Guidobaldo, in the following, puts the argumentation of Cardano's followers on and replies to possible objections. Conclusively, he again emphasises that not the position of the suspension arrangement is decisive, but the position of the centre of rotation of the balance, as he himself had shown in the second and third proposition of the *Mechanicorum Liber*.

Defence of Aristotle's treatment of the balance

After a digression about the difficulties to fabricate exact balances in general and isostatic ones in particular, Guidobaldo begins to attend to Aristotle's treatment of the balances exposed in the *Quaestiones Mechanicae* (fols. 23r-28r): the latter had claimed, in *Quaestio* II, that balances with the suspension arrangement above would return in the horizontal position if displaced before in an inclined one, and that balances with supporting arrangement below, in contrast, would continue to move downwards at the depressed side.[1]

As exposed above, the interpretation of this Aristotle's reasoning is controversial, yet it seems that he had erroneously attributed indifferent equilibrium to a balance of unstable equilibrium. In some respects, it is somewhat surprising that Guidobaldo sides with Aristotle: in fact, the former defends Aristotle's treatment on several pages – although he had not missed any occasion to criticise, in contrast, Jordanus, Tartaglia and Cardano.[2]

As first step in this purpose, Guidobaldo goes about proving the results of his second and third proposition having recourse which seems similar to the one exposed in *Quaestio* I of the *Quaestiones Mechanicae*: one could measure the effective heaviness of a weight by taking into consideration of the discrepancy between the way of its actual path of descent (forced by the beam of the balance) and its "natural" path of descent (i.e. the way along which it would fall if it were free to do it and free from obstacles).[3]

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de trutina et meta potius omittendum, ac silentio praetereundum esset, quam verbum ullum in eius confutatione sumendum, cum sit prorsus voluntarium. Necessitas enim cur pondus in D ex maiore angulo sit gravius curque maior angulus maioris sit causa gravitatis, nusquam apparet. (...) si angulus GCD est causa gravitatis, quare angulus FCE similiter gravitatis non est causa?"

[1] For a more detailed description of Aristotle's reasoning about the balance in the *Quaestiones Mechanicae*, cf. III.1.

[2] Guidobaldo has often been criticised in modern historiography of history of science because of his harsh critique towards Jordanus. This has often been interpreted as an *a priori* reputation of medieval science. Yet, as chapter I of Part B evidences, Guidobaldo could not have reacted otherwise – because of theory-inherent motivations. The really notable fact, instead, is his siding with Aristotle.

[3] As we have exposed above, this approach shows some analogies with the distinction of two different movements in the *Quaestiones Mechanicae* (*Quaestio* I): similarities can be identified

Guidobaldo proves that the weight in E has a less oblique descent compared to F (cf. figure IV.37), so it is positionally heavier, whence it has to go down -[1] correspondingly to what Guidobaldo had already shown in Proposition II, with different mechanical principles, though.

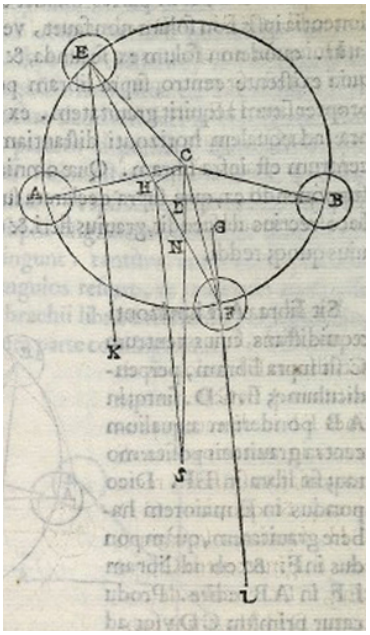

Figure IV.37: The demonstration of stable equilibrium without the use of the concept *centre of gravity*.

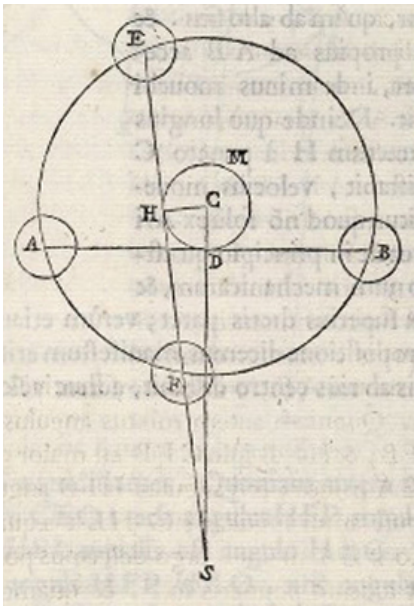

Figure IV.38: Guidobaldo's reasoning about the position of the balance from which its movement is fastest.

He expresses his agreement with Aristotle by interpreting his respective reasoning in the *Quaestiones Mechanicae* in the terms of the just completed prove: if we call N the intersection of CS and EF (cf. figure IV.37), so NE will be longer than NF. Thus CS, called *perpendiculum*, divides the balance EF in unequal parts, and the longer segment has consequently to go down.

Guidobaldo here inserts a two-pages-excursus on the velocity of the movement of the balance (cf. figure IV.38): he claims it is fastest when the prolongation of EF passes through the centre of the world S. In fact, if we consider the little

also with Jordanus' one, from which Guidobaldo started with the idea of a more or less "oblique descent" – yet, a decisive difference lies in the fact, that Guidobaldo here takes into consideration the descent of one weight with the *ascent* of the other, in contrast to Jordanus.

[1]Cf. *Mechanicorum Liber*, fol. 23v: "Erit angulus GFB angulo KEA maior. Ergo descensus ponderis in E minus obliquus erit ascensu ponderis in F. Et quamquam pondus in E descendendo et pondus in F ascendendo per circumferentias moveantur aequales, quia tamen pondus in E ex hoc loco rectius descendit quam pondus in F ascendit: idcirco naturalis potentia ponderis in E resistentiam violentiae ponderis F superabit. Quare maiorem gravitatem habebit pondus in E quam pondus in F."

circle DHM along which the centre of gravity of the two weights moves and if we call H the point where the centre of gravity is situated when EF passes though S, so CH is vertical to (the tangent of the circle) ES. Hence, the weight (concentrated) in H is positionally heaviest in H, as Guidobaldo had argued on the pages above. And thus, the magnitude composed by the weights E, F and the balance, with their centre of gravity in H, weight more in this position than in any other. Consequently,[1] it is from this position that it descends fastest. Further, the longer HC is the faster its movement is (obviously, EF has to lie on the line ES in all these cases).[2]

On the following two pages, Guidobaldo approaches the analysis of the balance of unstable equilibrium. He analogously demonstrates that such a balance moves down by the depressed side, in agreement to what Guidobaldo had already proved in Proposition III.
The truth of these two results about the balances of respectively stable and unstable equilibrium would be so clear, that they could be proved even on the foundation of his adversaries' erroneous principles.[3] By doing so, Guidobaldo goes about proving his aforesaid results about the balances of respectively stable and unstable equilibrium (fols. 26r/v), recurring to the concept of measuring the vertical components of the descent of the one, and of the ascent of the other weight. Then, he uses also the concept of the comparison of the *horizontal* components of the distances of the weights to the vertical axis.

Next, Guidobaldo attends to Aristotle's defence (fols. 26v-28v). First, he claims that Aristotle, despite of having dealt only with the balances of stable and unstable equilibrium (in the second *Quaestio*), doubtlessly he knew about the balance of indifferent equilibrium as well: he would have left this case out because it was too obvious.[4]

[1]Here, Guidobaldo implicitly refers the proportionality of weight and velocity of descent, another idea inspired by Aristotelian natural philosophy.

[2]Cf. *Mechanicrom Liber*, fol. 24r/v: "Quoniam autem CH ipsi EF est perpendicularis, continget linea EHS circulum DHM in punto H. Pondus igitur in H (sicuti supra demonstraviumus) gravius erit quam in alio situ circuli DHM. Ergo magnitudo ex EF ponderibus, et libra EF composita, cuius centrum gravitatis est in H, in hoc situ magis gravitabit, quam in quocunque alio situ // circuli fuerit puncutm H. Ab hoc igitur situ velocius quam a quocunque alio movebitur. Et si H propius fuerit ipsi D minus gravitabit, minusque ab eo situ movebitur; semper enim descensus obliquior est et minus rectus. (...) Deinde quo longius punctum H a puncto C distabit, velocius movebitur. Quod non solum ex Aristotele in principio *Quaestionum Mechanicarum* et ex superius dictis patet. (...) Libra igitur EF, quo magis ab eius centro distabit, adhuc velocius movebitur."

[3]Cf. *Mechanicorum Liber*, fol. 25v: "Ex ipsorum <Jordani, Tartaleae, Cardani> quin etiam rationibus ac falsis su<p>positionibus iam declaratos librae effectus ac motus deducere ac manifestare libet; ut quanta sit veritatis efficacia appareat, quippe ex falsis etiam elucescere contendit."

[4]Cf. *Mechanicorum Liber*, fol. 26v: "Aristoteles itaque has duas tantum quaestiones proposuit, tertiamque reliquit, scilicet cum centrum librae in ipsa est libra: hanc autem ommissit

Then, dal Monte comes to speak about the second part of the *Quaestio* II: in fact, Aristotle had not claimed that the balance goes on to sink downwards at the depressed side, but that it stayed at rest in that position. But in Guidobaldo's opinion, the Stagirite nevertheless was right if interpreted in the "appropriate" way.[1]

So, the Marchigian mathematician offers a tricky solution for this problem. He claims that Aristotle, in reality, considered a real, material balance, with a supporting device ("*trutina*") like in figure IV.39.

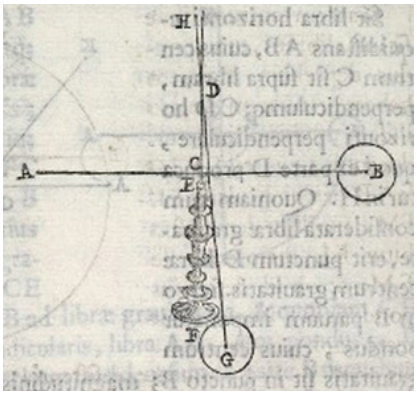

Figure IV.39: Guidobaldo's defence of Aristotle's treatment of the balance of unstable equilibrium. According to the former, one has to imagine that Aristotle referred to a balance similar to the figured one.

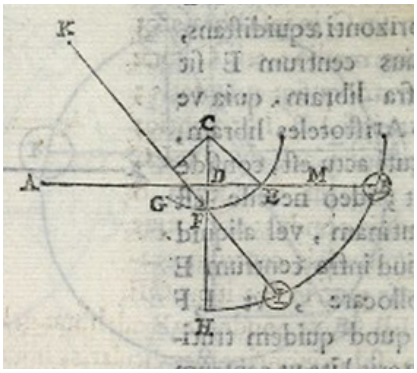

Figure IV.40: Excursus on the inclination angle of a balance of stable equilibrium if only to one of the balance arms is fixed a weight.

According to Guidobaldo, Aristotle considers the extreme case in which the weight B has moved down in G and does already touch the supporting device with its beam. Therefore, it cannot move downwards any more. And if one doffs the weight now, the beam will rest in this position: in fact, the part GD of the balance beam on the deeper side, determined by the *perpendiculum* ECD, is longer than DH, so this side would sink down; but as it cannot go down any more, the beam rests in this position. So Aristotle's theory is in plain concordance with his own one, as Guidobaldo states.[2]

---

ut notam, quemadmodum res valde notas praetermittere solet. Nam cui dubium, si pondus in eius centro gravitatis sustineatur, quin maneat?"

[1]Cf. *Mechanicorum Liber*, fol. 26v: "Nam cum in secunda parte secundae quaestionis proponit, cur libra, trutina deorsum constituta, quando deorsum lato pondere quispiam id amovet, non ascendeit, sed manet? Non afferit adhuc, libra deorsum moveri, sed manere. Quod in ultima quoque conclusione colligisse videtur. Verum hoc non solum nobis non repugnat, sed si recte intelligitur, maxime suffragatur."

[2]Cf. *Mechanicorum Liber*, fol. 27r: "Dicit Aristoteles, ponatur pondus in B, quod cum sit grave, libram ex parte B deorsum movebit, puta in G, ita ut propter impedimentum deorsum

Yet, the Marchigian mathematician goes on: maybe, Aristotle's adversaries might state that, if the weight is light, so it does not even move to the vertical position but stops before, as one can (really) observe for balances of stable equilibrium (cf. figure IV.40), considering the balances with material beams.

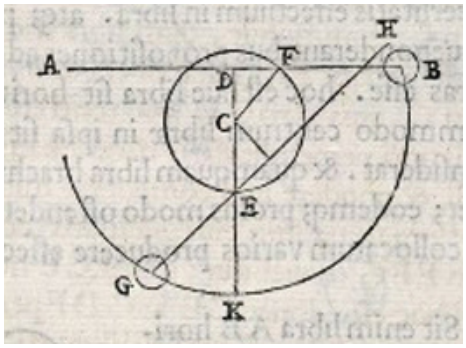

Figure IV.41: A balance of unstable equilibrium fulfills more than a quarter circle with the loaded arm, no matter how light the weight is. So his defence of Aristotle is valid.

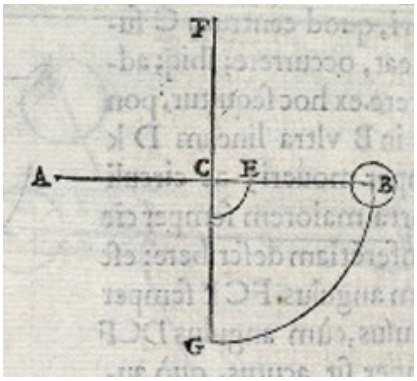

Figure IV.42: The isostatic balance moves to the vertical position if only to one arm is fixed a weight.

But, as he proves in the following, this happens only for balances of stable equilibrium, not for such one of unstable equilibrium (cf. figure IV.41).[1] And for the isostatic balance (cf. figure IV.42) it does not take much to show that it will stay

amplius moveri non poterit. Non enim dicit Aristoteles, moveatur libra ex parte B deorsum, quousque libuerit, deinde relinquatur, ut nos diximus; sed praecipit, ut in ipso B ponatur pondus, quod ex ipsius natura deorsum semper movebitur, donec libra trutinae, sive alicui alii adhaereat. Et quando B erit in G, erit libra in GH in quo situ, ablato pondere, manebit, cum maior pars librae a perpendiculo sit versus G, quae est DG, quam DH. Nec deorsum amplius movebitur, nam libra, vel trutinae, vel alteri cuipiam, quod centrum librae sustineat, incumbet. Si enim huic non adhaereret, libra ex parte G deorsum ex ipsius sententia moveretur, cum id, quod plus est, scilicet DG, deorsum ferri sit necesse."

[1]Guidobaldo approaches here a problem that was dealt with in the third book of the *De Rationis Ponderis*, cf. Moody&Clagett, *The Medieval Science of Weights*, and consequently published also in Tartaglia's *De Ponderositate*. Guidobaldo obviously uses, though, different mechanical concepts. He generalises this treatment, as he refers not only to balances of stable equilibrium, but also to such of indifferent and unstable ones. He reaches the same conclusion that the weight, as heavy as it may be, does not ever reach the perpendicular CH (cf. figure IV.40). Cf. *Mechanicorum Liber*, fol. 27v: "Si ergo in B parvum imponatur pondus, cuius centrum gravitatis sit in puncto B., magnitudinis ex libra AB et pondere in B compositae non erit amplius centrum gravitatis D, sed erit in linea DB, ut in E: ita ut DE ad EB sit, ut pondus in B ad gravitatem librae AB. (...) magnitudo ex AB et pondere in B composita minime in hoc situ manebit, sed deorsum secundum eius gravitatis centrum E per circumferentiam EFG movebitur [<per propositionem> 1 huius <libri>]. Donec CE horizonti perpendicularis evadat, hoc est, donec CE in CDF perveniat. (...) Si vero in B ponatur pondus gravius, centrum gravitatis totius magnitudinis erit ipsi B propius, ut in M, et tunc libra dorsum, donec iuncta CM in linea CDH perveniat, movebitur. Ex maiore igitur et minore pondere in B posito, libra

in the vertical position, no matter how light or heavy the weight attached at one side is.
As far as, in contrast, the balance of unstable equilibrium is concerned, the attached weight descends along a path that exceeds the quarter circle (cf. figure IV.41). In fact, be F the centre of gravity of the magnitude composed by the balance and the weight B. It will move downward (if it is not hindered), until F will be located perpendicularly below C, i.e. until it coincides with E. This happens no matter how light the attached weight is.
Guidobaldo concludes this thematic unit again emphasising that it is the (position of the) *centrum librae*, i.e. the centre of rotation, that determines the behaviour of the balance.[1] Then, he revisits the topic of the beginning of the long digression in the fourth proposition: the characteristic of the isostatic balance (to remain at rest in whatsoever position it has been brought, considering equal weights from equal distances) is exactly what Archimedes has known and referred to in his writings.[2]

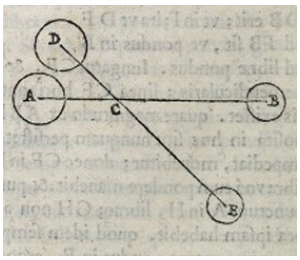

Figure IV.43: The isostatic balance for the case of unequal weights and distances.

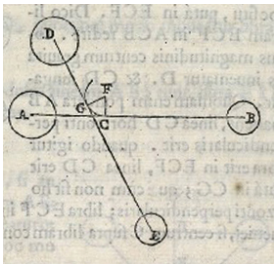

Figure IV.44: The balance of stable equilibrium for the case of unequal weights and distances.

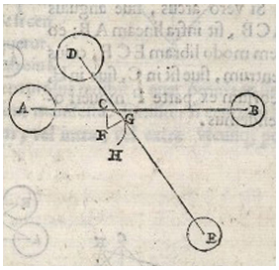

Figure IV.45: The balance of unstable equilibrium for the case of unequal weights and distances.

Generalisation and conclusive considerations

The conclusion of the digression of the fourth proposition is formed by several considerations concerning balances in general: First, Guidobaldo generalises his

plus minusve inclinabitur. Ex quo sequitur, pondus B quarta circuli parte minorem semper circumferentiam describere, cum angulus FCE sit semper acutus. Nunquam enim punctum B usque ad lineam CH perveniet, cum centrum gravitatis ponderis et librae simul semper inter DB existat."

[1]Cf. *Mechanicorum Liber*, fol. 28v: "His demonstratis manifestum est, centrum librae causam esse diversitatis effectuum in libra."

[2]Cf. *Mechanicorum Liber*, fol. 28v: "Atque patet omnes Archimedis *De Aequeponderantibus* propositiones ad hoc pertinentes in omni situ veras esse. Hoc est sive libra sit horizonti aequidistans, sive non: dummodo centrum librae in ipsa sit libra, queadmodum ipse considerat."

results about stable, unstable and indifferent balances,[1] to the case of unequal weights fixed at unequal distances. The properties of indifferent, stable and unstable, though, are preserved as long as the *centrum librae* is connected (or coincides) with the centre of gravity of the balance-system (cf. figures IV.43, IV.44 and IV.45).
At the end, he examines some "pathological" balances, i.e. such ones with curved or angular beams (cf. figures IV.46 and IV.47). Guidobaldo himself claims that these are not really balances ("quamquam haec proprie non sit libra"), so these are considerations of exclusively theoretical nature, treated in order to show that also in those cases one could speak of the different types of equilibrium.

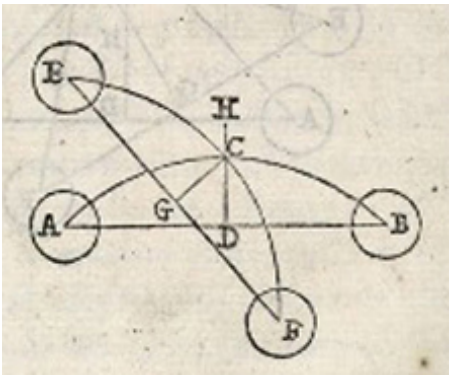

Figure IV.46: A curved balance.

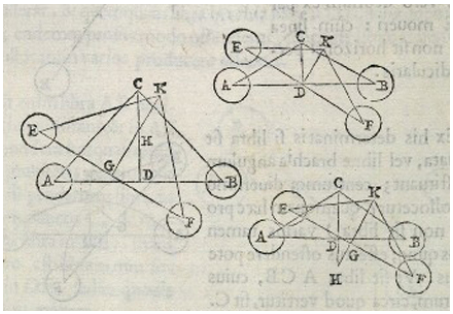

Figure IV.47: Different types of angular balances.

IV.2.3 Convergence vs. parallelism of the lines of action

So, Guidobaldo presents in the *Mechanicorum Liber* the conception of converging lines of action, let us shortly recall its occurrence in the fourth proposition of *De Libra*: it is introduced as *argumentum ad hominem* against Tartaglia: the latter, on the one hand, had postulated converging lines of action in his axioms,[2] but on the other hand, he had shown the impossibility of indifferent equilibrium recurring to *parallel* lines of action.[3] So, Guidobaldo took up this conception, in order to show that, if Tartaglia had applied it to his argumentation concerning the isostatic balance, his proof regarding the impossibility of indifferent equilibrium would not have held. Then, however, after his counter against Tartaglia, he applies this conception to other questions as well, which we want to analyse in the present

[1] As we have exposed, in Propositions II-IV Guidobaldo had referred only to the case of equal weights at equal distances.

[2] Tartaglia, in the first postulate of the eighth book of *Quesiti et Inventioni diverse*, explicitly states: "Adimandamo che ne sia concesso, che il movimento naturale de ogni corpo ponderoso e grave sia rettamente verso il centro del mondo." Also Jordanus had postulated this fact, in the *Elementa*, axiom I: "Omnis ponderosi motum esse ad medium."

[3] For a more detailed analysis of this question, cf. Part B, chapter I.

subsection. We should keep in mind that this question is not something like a theoretical curiosity: it has far-reaching consequences on a possible formalisation of the concept *moment*.[1]

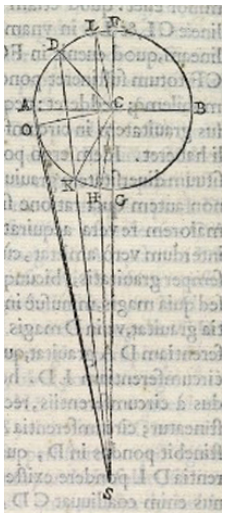

Figure IV.48: The conception of converging lines considering a weight on a rotatable beam.

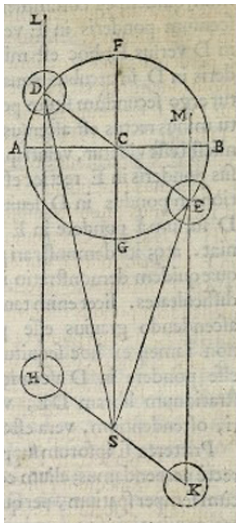

Figure IV.49: A compromise between the convergence and the parallelism of the lines of action.

As the last subsection has evidenced, Guidobaldo uses the conception of converging lines of action also when he investigates (fols. 8v-11v) for which inclination of a rotatable beam a weight, fixed on the beam, is positionally most heavy. He comes to the conclusion that this is not the case for the horizontal position of the beam (as claimed by Jordanus and Cardano), but when it forms a right angle with the line connecting the weight's barycentre and the centre of the world (cf. figure IV.48).
Some pages after (fols. 19v-20v), Guidobaldo presents a compromise between the two opposed conceptions fo the convergence and the parallelism of the lines of action, in the case of the balance: the weight in D would fall along DS to the centre of the world S, if it were able to move freely, and the weight in E analogously along ES (cf. figure IV.49). But this is the case if they are considered *autonomously*: on the contrary, if we treat the case of the two weights attached to the balance, so the connection of one weight with the other the situation changes: In fact, C is the centre of gravity of the magnitude composed by D, E and has the *propensio* to unify with the centre of the world, along the straight line CS. Once arrived there, the balance in HK will be parallel to the initial position DE, so the paths of the weights are EK and DH. Consequently, these are the lines of

[1] An analysis of this connection is exposed in Part B, II.4.6.

descent of the weights in the case of their connection by the device of the balance, and no longer the converging lines ES and DS.

Interestingly, Guidobaldo does not apply this convincing compromise in the course of the work. In the chapter *De Vecte*, he seems to oscillate between the conception of converging and parallel lines of action: in Proposition IX he considers the projections of the centre of gravity to the beam to be *perpendicular to horizon*,[1], and also in Proposition X he intersects the beam with the *perpendiculars* drawn from the barycentres of the weights.[2]
On the contrary, in Proposition VIII he considers the projections of the barycentres on the beam to be *both parallel and converging* to the centre of the world (cf. figure IV.50): "Further, be drawn HL, KM from H and K, perpendiculars to the horizons, which converge in the centre of the world".[3]

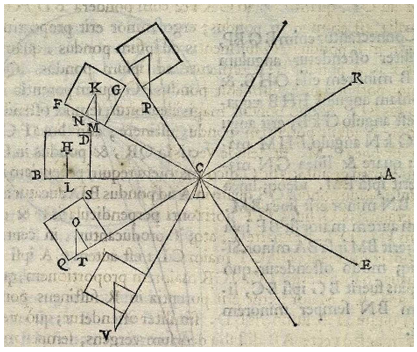

Figure IV.50: The lines of forces, that Guidobaldo uses in this figure, as KM, HL, OT, are drawn as parallels.

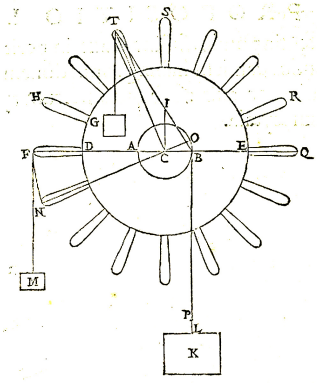

Figure IV.51: Guidobaldo compares the effective heavinesses of the weights acting respectively in T and B.

This identification certainly appears somewhat puzzling, in the light of his critique of Tartaglia regarding the theory of the isostatic balance. The only argument that could justify Guidobaldo's (at first sight?) incoherent reasoning is that Tartaglia

[1]Cf. *Mechanicorum Liber*, fol. 53r: "Sit M gravitatis centrum ponderis FH et a punctis LM ipsorum horizontibus perpendiculares ducantur $LKMN$."

[2]*Mechanicorum Liber*, fol. 56r: "Sit vectis AB, ex punctoque A suspendatur pondus C; hoc est punctum A semper sit punctum, ubi perpendicularis a gravitatis centro ponderis ducta vectem secat."

[3]Cf. *Mechanicorum Liber*, fol. 44r: "Deinde tum ex H, tum ex K ducantur HL, KM ipsorum horizontibus perpendiculares, quae in centrum mundi convenient." The plural "horizontibus" is rather strange: how should "horizons" be interpreted? And how can lines, perpendicular to the horizon be converging in the centre of the world? Was the very concept of *horizon* variable for Guidobaldo, in the sense that every point on the surface of the Earth had its own horizon? He does not ever affirm such a curious fact explicitly.

has considered an infinitesimal difference of *positional* weight; therefore, even so small differences as between parallel and converging lines of action have to be taken into account. For the treatment of the lever, there would not be need of such exact distinctions, as not infinitesimal magnitude is concerned.[1]

Another interesting passage in regard is the treatment of the winch, as he seems to recur to the conception first of parallel and then of converging lines of action: after the first proposition, Guidobaldo imagines the case in which weight and 'force' do not act in the horizontal plane. His intent is to show that, in order to hold a certain weight in k, a bigger weight has to be placed in T than in F.
The weight in T is supposed to hold the weight k in B (cf. figure IV.51). Be I the point on BT which lies vertically above C. As the weights are supposed to be in equilibrium, Guidobaldo correctly states the ratio between the weight in T and the one in B to be like BI to IT.[2]
Yet, instead of completing the elementary step applying the theorem of intersecting lines, and reaching a quantitative relation, Guidobaldo confines himself to make a qualitative statement. In fact, the equalisation $BI : IT = BC : CT'$ – where T' is the vertical projection of T to the horizontal FC – furnishes the effective lever arm CT' of the weight in T if and only if *parallel* lines of action are presupposed.[3]
Then, in a second step, he substitutes the weight in T by a 'force' which corresponds to the actual use of the winch, and states:

> But if, instead of the weight in T, there were an animated force holding the weight k, which pulled down as if it *wanted to tend to the centre of the world – as the weight fixed in T effects by its own nature* – so this force would be equal to the same weight fixed in T, otherwise it would not hold <the weight in k>.[4]

So, although Guidobaldo had stated the parallelism of the lines of action in his compromise in *De Libra*,[5] it was probably this fact of the convergence of the lines

[1] However, this justification is not forwarded by Guidobaldo, so it is not clear if this was the actual reason of his differing argumentations.

[2] Guidobaldo here recurs to the first proposition of *De Libra*: as the weights are supposed to be in equilibrium, I has to be the centre of gravity of the system. Consequently, the relation in question follows with the law of the lever.

[3] As IC and the cord to which the weight in T is attached, are both vertical and, thus, parallel, we have $BI : IT = BC : CT'$, where T' is the intersection of the vertical from T and the horizontal FC. As $BC : CT' > BC : CF$, the force in T' (and consequently in T) has to be bigger than the one in F, in order to hold the same weight in B.

[4] Cf. *Mechanicorum Liber*, fol. 108v: "Si vero loco ponderis in T animata potentia sustinens pondus k constituatur, quae ita degravet se, ac si in centrum mundi tendere velle, quemadmodum suapte natura efficit pondus in T appensum, erit haec eadem ponderi in T appenso aequalis; alioquin non sustineret." The emphasises are ours.

[5] Note: since Guidobaldo reduces all the Simple Machines to the lever which is identified, on its part, with a balance, the the parallelism of the lines of action would have to be valid also

that kept Guidobaldo from making the quantitative statement in the comparison between the weights to be applied in T and F to hold the weight k.

So, the preceding passages have revealed Guidobaldo's oscillation between the conception of converging and parallel lines of action in the *Mechanicorum Liber*: despite of the convincing compromise proposed on fol. 19v in chapter *De Libra*, he does not seem to have reached an unambiguous opinion in regard. This incoherence between the respective passages might be caused by different layers of elaboration: we know that Guidobaldo worked probably several years on the book (cf. Part A, I.2).[1]

Interestingly, also in other works Guidobaldo appears to be rather irresolute concerning this question: one of the relevant passages is his critique against Benedetti's mechanical theory of the *Diversarum Speculationum Liber*, exposed on the pages 145-146 of the *Meditatiunculae*. Even if it is not easy to come out with a clear idea of what Guidobaldo's conception was,[2] it seems that Guidobaldo agreed with the idea to measure the effective lever arms by means of the horizontal projection, criticising though exactly this idea exposed by Benedetti.

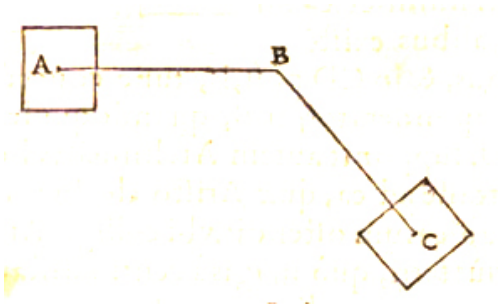

Figure IV.52: Guidobaldo's hint to the angular balance at the beginning of the *Paraphrasis*.

Then, in the *Paraphrasis* (p. 25), he points out that the reader should be cautious with the statement "equal distances" in the case of angular balances: even if AB and BC are equal, the equal weights A and C will not equiponderate (cf. figure IV.52). Interestingly, though, he does not mention the measuring of the effective distance by means of the vertical projection at all, neither on this opportune occasion nor anywhere in the following – on the contrary, shortly before,

for the other Simple Machines.

[1] Long times of elaborations do not seem to have been unusual for Guidobaldo: he worked nearly ten (!) years on his *Perspective*, as well. Further, after the start of the works on the *Cochlea* in 1589 (circa), he did not succeed in completing and publishing it before his death in 1607.

[2] An analysis of these entries is exposed in Part A, VI.2.1.

he speaks of weights which tend to the centre of the world...[1] Surely, such an *argumentum ex silentio* should not be overestimated. Yet, against the background of Guidobaldo's indecision regarding this question in other writings, this passage seem to confirm that Guidobaldo did not come to a conclusive opinion about the problem. He differs, in this consideration of the angular balance, remarkably from Benedetti (in the *Diversarum Speculationum Liber*) and Galileo (in *Le Mecaniche*): both of them had introduced, in the same occasion, the idea of the vertical projections.

IV.2.4 *Potentia sustinens* vs. *Potentia movens*: the problem of motion and first steps to a compensation principle

An important conceptual element of the *Mechanicorum Liber* is Guidobaldo's distinction between the 'force' able to hold a weight (by the device of a Simple Machine), "*potentia sustinens*", and the 'force' able to move a weight, "*potentia movens*". It is closely connected with another relevant aspect of the *Mechanicorum Liber*, i.e. his first steps to the statement of a general principle of the Simple Machines.

The distinction between *Potentia sustinens* and *Potentia movens*

The statements on the movement of weights by device of the machines accurately distinguish between the two aforesaid kinds of 'forces': the first corollary of Proposition XIV, for example, states that the ratio of the weight to the *potentia sustinens* is equal to the ratio between the space covered by the *potentia movens* and the space covered by the weight.[2] The same statement is made for the winch,[3] and for the lever.[4] So what did Guidobaldo mean with this distinction?
The Corollary to Proposition IV gives us a first hint: Guidobaldo claims that

> The *potentia sustinens* is smaller than the *potentia movens*.[5]

[1] *Paraphrasis*, p. 24: "Et haec quidem aequeponderatio tam ponderibus in libra appensis, quam in ipsa (ut dictum est) constitutis competit: dummodo ea, quibus appenduntur pondera, libere semper in centrum mundi tendere possint."

[2] *Mechanicorum Liber*, fol. 82v: "Ex his manifestum est ita se habere pondus ad potentiam ipsum sustinentem, sicuti spatium potentiae moventis ad spatium ponderis moti."

[3] Even the wording is identical, with three exceptions, cf. Crollarium I to Proposition I, *Mechanicorum Liber*, fol. 109v: "Ex his manifestum est ita esse pondus ad potentiam sustinentem, ut spatium potentiae moventis ad spatium ponderis moti."

[4] *Mechanicorum Liber*, Corollary to Proposition IV, fol. 43r/v: "Spatium enim potentiae <moventis> ad spatium ponderis <moti> eandem habet, quam pondus ad potentiam pondus sustinentem."

[5] *Mechanicorum Liber*, fol. 43v: "Potentia vero sustinens minor est potentia movente."

What were the reasons of this conception? A letter written to G. Contarini in 1580 is very illuminating in regard:[1]

> Ora fatto questo, circa il mio libro <*Mechanicorum Liber*> e d'avvertire una cosa molto principale la quale ha fatto ingannare molti circa le esperienze: che è ch'io fo gran differenza dalla forza che sostiene un peso, e da la forza che lo move. Come per essempio nella terza proposizione *De Trochlea* dove dice: se la fune sarà menata per due girelle etc., che allora la potenza che sostiene sarà la metà manco del peso. Questo l'esperienza Glelo mostra giustissimamente in questo modo: La metta in alto le taglie come sta la figura di detta terza proposizione e La metta in A un peso di sei libre, et in N vi attacchi un peso di 3 libre il quale fara l'offitio della potenza <cf. figure IV.53>; senza dubbio La trovarà che staranno fermi, et questo è quanto alla schietta proporzione.
>
> Ma perché in atto pratico in questo caso la taglia di sotto, dove è attaccato il peso, ancor ella ha gravità, però bisogna pesar la taglia et il peso insieme e la metà del tutto metter in N. Come se, per essempio, il peso con la taglia pesaranno 7 libre, bisogna in N attaccarvi 3 libre et $1/2$, sì come io avertisco a carte 101 nella seconda facia, dove in qualche caso bisognarebbe considerar ancora la gravità delle funi, la quale in questo caso si può tralasciare, massime per le taglie piccoline, per adoperarsi spaghi et cordicelle sotili. Et in questo modo le 3 libre et $1/2$ in N et le 7 in A staranno ferme, perché le 3 libre et $1/2$ in N non hanno forza di mover le sette in A, né queste di mover le 3 $1/2$ in N, come dimostra la dicianovesima proposizione del medesimo trattato *De Trochlea*.
>
> Per aver adunque la potenza cognita, quando io parlo e che dico "*potentia sustinens*", si ha da intender che l'abbi tanta forza che la facci star il peso immobile, cioè sospeso e non più, e non come hanno creduto alcuni, che questa forza abbi da mover il peso, perché la sua forza et il suo valore è solo bastante a sostenere e non a mover il peso, e così si ha da intendere sempre questo termine *potentia sustinens*, sì come s'intende chiaramente dal corollario della prima proposizione *De Troclea*."
>
> Et se La considerarà nei problemi che sono nel libro, nei quali io propongo de mover i pesi, allora io fo la potenza sempre maggiore di quella che sostiene, et in questo modo Gli riusciranno benissimo tutte le esperienze. E così bisognava fare per provar la giustezza e la

[1] Cf. BNMV, mss. It IV, 63 (Ven 259). Published in A. Favaro, *Due lettere inedite di Guidobaldo del Monte a Giacomo Contarini*, in "Atti del Reale Istituto Veneto di scienze, lettere ed arti", LIX 2 (1899-1900), pp. 307-310. The complete transcription of the letter is exposed in Appendix I, I.8.2.

proportion che ha la forza con i pesi: perché, stando nel medesimo esempio, e le 3 libre e 1/2 in N sostentano il peso in A, la ragion vuole se in N si metterà un peso maggiore di 3 libre e 1/2, che questo senza dubbio mova il peso di 7 in A, ma questo che move pol esser 4 libre, 5, 6, 10, 20, 100 libre e così in infinito, e però non se ne può dar regola certa.
È ben vero che in questo la materia fa qualche ressistenza, che se sopra le 3 libre e 1/2 poste in N se gli aggiongesse un peso di minima gravità come un gran di miglio, allora se ben saranno più di 3 1/2, non per questo moveranno le 7 in A; e questo ne è causa la materia, la qual vuol la parte sua ancor lei, e quanto sono più grandi in materia, tanto più ressiste; sì come si prova tutto il giorno nelle libre che, per picole e giuste che le siano e che abbino pesi da tutte due le bande eguali e giusti, nondimeno a un di loro se gli potra metter sopra et aggiunger un peso di tanto poco momento come un minimo pezzolino di carta, che la bilancia starà senza andar giù da detta parte, né per questo la bilancia sarà falsa.
Dove è da considerare che la ressistenza che fa la materia lo fa quando si hanno da mover i pesi e non quando se hanno da sostenere solamente, perché allora l'instrumento non si move né gira, e con queste considerazioni La trovarà sempre che l'esperienza e la demostratione andaranno sempre insieme.

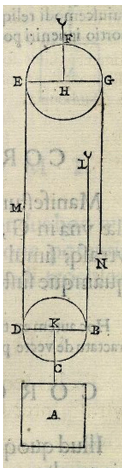

Figure IV.53: The figure of the third proposition *De Trochlea* referred to in Guidobaldo's letter to Contarini.

Several points of this letter seem to be crucial for our purpose: it seems that the difference between *potentia movens* and *potentia sustinens* substantially derives from the influence of matter. In fact, a force bigger only by a millet seed than the *potentia sustinens* would move the weight, but in reality it does not and "the cause

of this is matter". Analogously, from a theoretical standpoint the equilibrium of a balance would cease if even a minimum of weight would be added to on of the weights. Yet, in reality, one notices that, despite of adding "a weight of such little moment as a minuscule piece of paper, the balance remains in equilibrium without descending at the respective side; but the balance is not out of order for this reason".
This effect of matter entails that it is not possible, according to Guidobaldo, to state with exactness the value of the *potentia movens*: in fact, it can be bigger by a millet seed or, with the Guidobaldo's numerical example, "4 *libre*, 5, 6, 10, 20, 100", yet: "there cannot be a quantitative (*certa*) rule".

The same attitude is expressed 22 years later in the famous letter exchange with Galileo about the pendulum: unfortunately, we have only Galileo's answer to Guidobaldo's epistle, but from the formers words the latter's opinion is clearly deducible:

> I appreciate very much what Your Illustrious Lordship says, that when we begin to consider matter, so the propositions, contrived by the geometer abstractly, begin to alter for the contingency of matter. And as no reliable (*certa*) science can be established with these so obfuscated propositions, so the mathematician is absolved from the reasoning about them.[1]

This opinion seems to have been one of the reasons why Guidobaldo disagreed with the isochronism of the pendulums, proposed by Galileo in the letter. If the latter's summary corresponds to what the Marchigian mathematician had written, Guidobaldo had claimed that the modification of the geometrical models by matter rendered impossible the mathematical description of phenomena connected with motion, as with the *potentia movens* or the motion of the pendulum. It has been said that "the *Liber Mechanicorum* represents a forceful argument that statics and dynamics are entirely separate sciences and so no unified science of mechanics is possible".[2] This was essentially led back to the "return in statics to the rigorously mathematical method of Archimedes",[3] established by Guidobaldo's principal mechanical work. Apart from the anachronistic and inappropriate distinction of statics and dynamics in pre-newtonian mechanics, the point is a different one, in our opinion: rather than his undoubted exigency of mathematical rigour, the decisive reason for his general abstinence from the consideration of phenomena connected to motion seems to have been this: he appears to have been firmly convinced that phenomena depending on the properties of

[1] Stimo benissimo detto quanto ne dice V.S. Ill.ma, e che quando cominciamo a concernere la materia, per la sua contingenza si cominciano ad alterare le proposizioni in astratto dal geometra considerate, delle quali così perturbate siccome non si può assegnare certa scienza, così dalla loro speculazione è assoluto il matematico.

[2] Cf. P.L. Rose, *The Italian Renaissance of Mathematics*, cit., p. 233.

[3] *Ibid.*

matter, e.g. those relative to motion, were not subject to any mathematically determinable rules – which had to form, though, the foundation of any science. This conviction excluded any systematic kind of studies on phenomena connected to motion.
So, this negative effect of matter – "matter (...) wants its part as well" – entailed also the distinction between the two kinds of forces.

A completely different conception was held by Galileo. In *Le Mecaniche* he comes to the conclusion that bodies can be moved by any smallest force along the horizontal plane:[1]

> E così veggiamo, essempli grazia, l'acqua non solamente cadere a basso a perpendicolo da qualche luogo eminente, ma ancora discorrer intorno alla superficie della terra sopra linee, benché pochissimo, inclinate. (...) il quale medesimo effetto, come si scorge in tutti i corpi fluidi, apparirebbe ancora nei corpi duri, purché e la lor figura e li altri impedimenti accidentarii ed esterni non lo divietassero. Sì che, avendo noi una superficie molto ben tersa e polita, quale saria quella di uno specchio, ed una palla perfettamente rotonda e liscia o di marmo o di vetro, o di simile materia atta a pulirsi, questa, collocata sopra la detta superficie, anderà muovendosi, purché quella abbia un poco d'inclinazione, ancorché minima, e solamente si fermerà sopra quella superficie, la quale sia esattissimamente livellata ed equidistante al piano dell'orizonte; quale, per essempio, saria la superficie di un lago o stagno agghiacciato, sopra la quale il detto corpo sferico staria fermo, ma con disposizione di essere da ogni piccolissima forza mosso. (...)
> Dal che possiamo prendere, come per assioma indubitato, questa conclusione: che i corpi gravi, rimossi tutti l'impedimenti esterni ed adventizii, possono esser mossi nel piano dell'orizonte da qualunque minima forza.

So, even if Galileo does not refer to the forces applied at the Simple Machines, it is not difficult to generalise his argumentation and to comprehend that only exterior causes like friction or other phenomena cause the (justified) sensation that to move bodies there needs to be applied force, or that the force to move a body is bigger than the one to hold it.

First steps to the *compensation principle*

Despite of Guidobaldo's fundamental scepticism about the possibility to develop a mathematical theory of motion, he had indisputably done important steps in the investigation of moving forces concerning the Simple Machines: he had had the remarkable idea to consider, besides the relation between force and weight,

[1] Cf. G. Galilei, *Le Mecaniche*, critical edition by R. Gatto, Firenze, Olschki, 2002.

also the spaces covered by them and the times required for their movements. And so he had discovered – and proved – for lever, pulley and winch that the weight is to the *potentia sustinens* as inversely proportional to the ratio of the spaces covered by the *potentia movens* to the one covered by the weight; and consequently also the times required for their movements.
Now, with the conception that there is no substantial difference between the *potentia sustinens* and the *potentia movens*, Guidobaldo's insight could be easily transformed in the rule that the ratio force-weight is inversely proportional to the spaces covered by them or the times of their movements. This means that as much as is gained in force, by the use of the Simple Machines, the much is lost in space or time, i.e. the advantages of the machines are *compensated* by disadvantages regarding other physical magnitudes. This idea is clearly stated in Galileo's *Le Mecaniche*:

> (...) Dei quali inganni parmi di avere compreso essere principalmente cagione la credenza, che i detti artefici hanno avuta ed hanno continuatamente, di potere con poca forza muovere ed alzare grandissimi pesi, ingannando, in un certo modo, con le loro machine, la natura; instinto della quale, anzi fermissima constituzione, è che niuna resistanza possa essere superata da forza, che di quella non sia più potente. (...)
> Percioche, quando bene la forza fusse picciolissima, dividendosi il peso in molte particelle, ciascheduna delle quali non resti superiore alla forza, e trasferendosene una per volta, arà finalmente condotto tutto il peso allo statuito termine. Né però nella fine dell'operazione si potrà con ragione dire, quel gran peso esser stato mosso e traslato da forza minore di sé, ma sì bene da forza la quale più volte averàreiterato quel moto e spazio, che una sol volta sarà stato da tutto il peso misurato. Dal che appare, la velocità della forza essere stata tante volte superiore alla resistenza del peso, quanto esso peso è superiore alla forza; poiché in quel tempo nel quale la forza movente ha molte volte misurato l'intervallo tra i termini del moto, esso mobile lo viene ad avere passato una sol volta.

So Galileo, plausibly inspired by Guidobaldo's demonstrations, had identified a general rule of the Simple Machines, not any more as corollary, but as principle of their operation. This usually called "*compensation principle*",[1] in order to distinguish it from the *conservation principle*, which, after the identification of the physical magnitude *work*, generalised the former principle relative to the mechanical machines.

[1]This is the terminology adopted by M. Camerota, M.O. Helbing, *All'alba della scienza galileiana. Michel Varro e il suo* De Motu Tractatus, CUEC, Cagliari, 2000: Varro's treatise is another interesting writing in regard of the presence of such a *compensation principle*.

Chapter V

The *Paraphrasis*

Historiography of mechanics has not dedicated much attention to the Paraphrasis *so far. The present chapter intends to argue, however, that it is a relevant writing for comprehending Guidobaldo's complex scientific work. It further constitutes, more generally, an important element of the restoration of Greek mathematics. Up to now, the treatise has been almost exclusively interpreted as manifestation of the* Archimedean revival*, of Guidobaldo's eagerness to follow in Commandino's footsteps and to complete his work of restoring Greek mathematics. Yet, it seems that it would be too reductive to consider this as the only reason that induced Guidobaldo to compose the treatise. Rather, a most important aspect of the work is constituted by the defence of Guidobaldo's theory of the indifferent equilibrium concerning the isostatic balance. Further, some passages appear to be reflections or stimuli of his teaching and discussions both in the "technicians" and in the "philosophers" circle. This is connected with the fact that the* Paraphrasis *probably resulted from elaborations of Guidobaldo's textbook of the lectures on Archimedes's* Equilibrium of Planes.

V.1 Contextualisation

The circumstances in which Guidobaldo composed the *Paraphrasis* were rather different compared to those of the *Mechanicorum Liber*. In fact, the years 1574-77 brought radical changes to Guidobaldo's life which had far-reaching consequences also for his scientific work after the *Mechanicorum Liber* (1577): in the first half of the seventies, Guidobaldo must have had a rather carefree life as courtier and one of the most intimate subjects and friends of Prince Francesco Maria, with enough leisure to study together mathematics under Commandino, and apparently also philosophy. The accession to the throne of Francesco Maria in 1574 and Commandino's death in 1575 changed this situation drastically: with the leaving of great part of the old Duke's intimates and collaborators, Guidobaldo had to take more administrative responsibilities at the Duke's side, for example in his

role as chief of his lifeguard. Further, after Commandino's death, he became a kind of "court mathematician", which entailed consequences not only for his scientific activity: as the Duchy's authority of mathematics and mechanics, he was regularly commissioned with tasks connected with architecture, engineering and the construction of mechanical clocks. As far as the extant documents reveal, the culmination of these activities were the 1580s, i.e. the years in which Guidobaldo worked on the *Paraphrasis*.

Besides these altered circumstances connected with Guidobaldo's close relation with Francesco Maria II della Rovere and the ducal court, still other changes influenced the context of his work in the course of these years in which Guidobaldo had gained at least national reputation: the extant documents testify that Guidobaldo more and more became the centre of a circle of scholars with mechanical, mathematical and philosophical interests. And it was probably in these years that he had to begin his lessons of mathematics, mechanics and architecture for future engineers and architects, most presumably at the new Duke's instance.
So on the one hand, the manifold duties he was commissioned with by Francesco Maria II limited the time at Guidobaldo's disposal for his scientific activity. On the other hand, his intensified collaboration with architect-engineers and technicians as well as his scientific debates offered him new stimuli.
Further, the Marchigian mathematician did not deal exclusively with mechanics in the meantime: he attended also to other mathematical branches like perspective and astronomy, with his works on the *Planisphaeriorum universalium Theorica* (1579) and his treatise on the calendar reform *De Ecclesiastici Calendarii Restitutione Opusculum* (1580).

The result of these circumstance was that eleven years had to pass until the edition of Guidobaldo's next mechanical work, the *Paraphrasis* (1588). A possible triggering moment was constituted by the publication of Giovanni Battista Benedetti's *Diversarum Speculationum Liber* (1585): therein, the Venetian mathematician had not accepted Guidobaldo's theory of the indifferent equilibrium for the isostatic balance, and had further approached to explain some passages of Archimedes's *Equilibrium of Planes*.
Yet, it would be myopic to conceive the *Paraphrasis* as a work without any connection with the *Mechanicorum Liber*, as has been done until now. Even if it has been created under different circumstances, the present chapter will evidence that there was a conceptual connected between the two work with so different topic:[1] namely, again, the indifferent equilibrium.
Before we start to analyse the most important elements of the *Paraphrasis*, it is advisable to dwell a bit on certain topics that turn out to be important for a better comprehension of the work: firstly, Guidobaldo's interest in philosophy

[1] Cf. particularly Part A, V.2.3.

in general and in problems related to natural philosophy in particular; secondly, the "philosopher's circle" around him in the years in which he worked on the *Paraphrasis*.

V.1.1 Guidobaldo's interest in philosophy[1]

Guidobaldo is well known for his uncontested qualities as mathematician, for his activity as military engineer and, thanks to recent studies, also for having been a prestigious architect.[2] However, confining ourselves to consider Guidobaldo as occupied principally with pure mathematics or tasks in the capacity of engineer, entails the risk to disregard a facet of his, which in effect has not been taken into account so far: i.e. Guidobaldo's interest in and occupation with philosophy in general and natural philosophy in particular. As the present chapter reveals, this circumstance should be kept in mind for a better understanding of certain elements of his scientific work.

As Guidobaldo's biography (cf. Part A, I.2) has documented, the Marchigian mathematician grew up at the side of the Prince and future Duke Francesco Maria II della Rovere, at the ducal court – noted in all Italy for its culturally rich ambiance – where philosophical debates seem to have taken place regularly. Tiberio Almerici's narration of the festivities at court in occasion of Carnival 1574 is highly informative in regard,[3] as it offers an insight in the cultural habits at that court with pronounced humanistic traditions:[4] the discussions about philosophical and literary topics, significantly held in the presence of Prince and Duke, dealt with the Aristotelian and Platonic theories on reminiscence; the notion of *pleasure* in Epicure and his reception in Cicero and Plutarch; the concept of *odium* in relation to *amor* or with Virgil's *Aeneid* and the literary genre of *epic poem*, and were argued out by the philosophers Jacopo Mazzoni, Cesare Benedetti, Pino di Cagli and the poet Torquato Tasso.
Another description of similar discussions, in L. Agostini's *Le Giornate Soriane*,[5] testifies that such discussions were typical for the courtly *milieu* and that they were no isolated cases.
Guidobaldo must have remained impressed by discussions of that kind, to such an

[1]The term "philosophy" hereby is intended in a large sense: it means both Guidobaldo's occupation with philosophical theories, e.g. exposed in Aristotle's *Politics*, as well as his interest in questions of "natural philosophy", i.e. the branch of philosophy that attended to the explication of phenomena relative to motion.

[2]For further information on these topics, cf. IV.1.

[3]Almerici's letter is transcribed in Appendix I, I.2.2, cf. particularly pp. 436-437.

[4]Surely, the narrated episode refers to a time, when Guidobaldo was 29 years old, i.e. after his youth. Yet, as other documents testify (cf. below), such discussions took place regularly, thus, with all probability, also during Guidobaldo's youth.

[5]Some passages of this work are transcribed in Appendix I, I.2.3. It has recently been published, cf. L. Agostini, *Le Giornate Soriane*, ed. by L.S. Firpo, Roma, Salerno, 2004.

extent that "he went to Padua to study Philosophy",[1] even if then his increasing passion for mathematics made him change his mind. However, despite of his subsequent activity as mathematician and engineer-architect, he seems not to have abandoned his occupation with philosophy. So, in an incomplete, posthumous eulogy he is referred to as "philosophus ac mathematicus".[2] Correspondingly, BOP, ms 758 adduces among his six main interlocutors three (at least locally) famous philosophers, namely Federico Bonaventura, Cesare Benedetti and Jacopo Mazzoni[3].
Especially the latter one was highly appreciated by Guidobaldo: so, the Marchigian mathematician once confessed Galileo his envy for not being sometimes at Pisa to discuss with both Galileo and Mazzoni – Mazzoni was professor of philosophy at Pisa, contemporaneously to Galileo.[4]
Finally, it does not appear to hazardous to suppose that Guidobaldo attended the lectures of philosophy for Francesco Maria II della Rovere. The Prince was highly interested in this subject – he studied for over *fifteen* years all philosophical writings of Aristotle under one of Guidobaldo's interlocutors, Cesare Benedetti -[5], and given both Guidobaldo's integration in the courtly life with excellent relations to Francesco Maria in those years and his acquaintance with the Prince's teachers,[6] this circumstance seems rather plausible.

As chapter II of Part A has evidenced, Guidobaldo was the centre of a scholars' circle, composed by noblemen of various professions and interests. As the subsequent subsection V.1.2 will show, a central element of their debates was constituted by discussions on philosophical questions.

[1]Cf. BOP, ms 758: "<Guidobaldo> andò a Padoa per lo studio della filosofia". See Appendix I, II.2.

[2]The author of this unfinished *Vita of Guidobaldo* is Sebastiano Macci, a local writer and biographer, contemporary of the Marchigian mathematician. The collocation of the document is BOP, ms 382, fols. 129r-130r. Except for the just cited denomination, it does not contain information beyond the elements reported by the accounts exposed in Appendix I, chapter II.

[3]Mazzoni was closely connected with the dal Monte family, especially with Francesco Maria dal Monte, who was his fellow student at Padua and who hosted him during the Carnival-weeks of 1574.

[4]Guidobaldo wrote to Galileo, on December 8th 1590: "mi rallegro che con il Signor Mazzone si dia bel tempo, non senza mia invidia, che vorrei esser alle volte nel mezzo a tutti due e goder de' suoi ragionamenti; al qual Signor Mazzoni V.S. da mia parte facci un grandissimo saluto et un lunghissimo bascia mano." The letter is published in G. Galilei, *Opere*, vol X.

[5]For further information on this topic, cf. section II.1. It is important to consider that these account refer to the 1570s and '80s, i.e. before the breakup of the excellent relations between Guidobaldo and the Duke.

[6]Francesco Maria II's teachers of philosophy were Cesare Benedetti, Felice Paciotti, Iacobo Mazzoni, and Cristofero Guarimone, cf. BOP, ms 386, fol. 223r/v; or cf. Part A, section II.1. All of them, with the possible exception of Cristofero Guarimone, were closely connected with Guidobaldo.

Guidobaldo's interest in philosophy in general

Precious information on Guidobaldo's interest in philosophy can be found in his correspondence. For example, he discussed with Pier Matteo Giordani about Aristotle's *Politics*: he wrote to his friend to have "read with great pleasure the eleventh chapter of the seventh <book> of <Aristotle's> *Politika*, which shows that <Aristotle> has known everything; where, with few words, he has said many things that would give rise to far-reaching reflections about this topic".[1] Giordani's answer is not conserved, but Guidobaldo's reply shows that his friend had made a comment on the practical application of what described in Aristotle. The Marchigian mathematician, though, reflects on the difference between "modern" and "antique" practice in politics.[2]

Another occasion for a philosophical-cosmological debate between the two scholars was given by the appearance of the nova in 1604 -[3] clearly, this event aroused the interest of Guidobaldo also in the capacity of astronomer. Yet, as the documents exposed in the following show, he was more interested in the *philosophical* consequences of this new appearance than in astronomical details.
Guidobaldo, in the meantime exiled to his feud in Monte Baroccio,[4] received through Pier Matteo Giordani observation dates made by other astronomers, like Johannes Kepler, Giovanni Antonio Magini, Christoph Clavius etc: obviously, the subject stirred up an uproar in the circles of philosophers and mathematicians because the new appearance, if interpreted as superlunary phenomenon would have represented an open contradiction to the incorruptibility of heavens, one of the cornerstones of the Aristotelian philosophy-cosmology.
Guidobaldo's first letter on the topic is dated November 23rd.[5] Therein, he told his friend about his observations of the celestial phenomenon, despite of bad meteorological conditions and shows to have understood, from the very beginning, the importance of parallax measurements, in order to discover the phenomenon's nature. Interestingly, he sent Giordani Mazzoni's *Discorso sulle Comete* – according to Guidobaldo's "among the best" works of his appreciated philosopher

[1] Cf. BOP, ms 426, fol. 189r; December 31st 1604: "Et ho letto con mio molto gusto l'undecimo capitolo del <libro> settimo della *Politica* <di Aristotele>, di quello che si vede che ha saputo ogni cosa, dove con poche parole ha detto tanto, che daria gran campo a ragionar di questa materia."

[2] Cf. BOP, ms 426, fol. 190r/v; January 20th 1605: "Delle cose politiche che V.S. va cercando con la teorica, e che poi la pratica non Gli riesce, non se ne maravigli, perché con la teorica va cercando le cose antiche, et però la pratica moderna non si può accomodar con quella teorica. V.S. adunque cerchi la teorica moderna e così Gli riuscirà."

[3] The letters cited in the following are published in G. Arrighi, *Un grande scienziato italiano: Guidobaldo dal Monte in alcune carte inedite della Biblioteca Oliveriana di Pesaro*, in "Atti dell'Accademia Lucchese di Scienze, Lettere ed Arte", XII, Firenze, 1965.

[4] Cf. Part A, I.2.

[5] Its collocation is BOP, ms 426, fol. 185r.

friend – which apparently confirmed Guidobaldo's consideration of the new object as a comet and not a star.[1]
In his next epistle, Guidobaldo becomes more explicit: he takes side with Mazzoni against Giordani, but concedes that also the *Discorso* is not without problems. Remarkable is Guidobaldo's judgement that

> those who want it to be a star, claim this in order to save the difficulties easily and without problems, because it is easy to say that the heavens are corruptible. But this fact is contrary to the whole philosophy and there would be need to find other principles.[2]

In this passage, Guidobaldo reveals his clear pro-Aristotelian position – "the whole philosophy" exactly means "Aristotelian philosophy" from his standpoint.
Contemporaneously, he urged Giordani to get observation dates from Rome (made by Clavius, via a friend of theirs, Omero Tortora) and from "Alemagna", i.e. Prague (Johannes Kepler), with which, combined with his own ones, he wanted to "save that is is a comet and not a star. For I cannot agree that some erudite persons promptly want to consider the heavens as corruptible, in order to be able to call it star".[3]
After having received the observations from Prague, Guidobaldo once again stresses in the successive letter the difficulty from the philosophical standpoint to regard the phenomenon as a star. Most interestingly, he sided with the philosophers and attacks the "mathematicians":

> And the mathematicians will soon agree to call it star, yet they will not know how to reply to the philosophers' reasons that the heavens are incorruptible and do not suffer these novelties. These problems would have to be resolved if it were true that this comet is a star.[4]

[1]Mazzoni's treatise has remained manuscript and seems to be conserved in the Vatican. Notice about it are contained in the detailed study of Mazzoni's life and work in F. Purnell, *Jacopo Mazzoni and his comparison of Plato and Aristotle*, Ph.D.-thesis, Columbia University, 1971; cf. p. 22, note 84: "Mazzoni then <in July 1596>" composed a *Discorso* on the comet for the Grand Duchess, Cristina di Lorena, which exists in two manuscripts in the Vatican. Serassi <*La vita di Jacopo Mazzoni*, Rome, 1790> notes that this treatise was highly regarded by the astronomer Guidubaldo de' Marchesi del Monte, who owned a copy. Mazzoni was also involved in a discussion on comets in Pisa in the Fall of 1589, when another such body had appeared and a crowd gathered to hear him explain the phenomenon. See Serassi, pp. 95-96."

[2]Cf. BOP, ms 426, fol. 187r/v; December 6th: "Questi poi che vogliono che ella sia stella, lo dicano per salvar facilmente e senza difficultà le difficoltà, perché è facil cosa a dire che'l Cielo sia corruttibile, ma che'l sia, questo ripugna a tutta la filosofia e bisognaria trovar altri principii." Note that Pier Matteo Giordani's replies are not preserved; their content can be partly reconstructed by Guidobaldo's answers.

[3]Cf. BOP, ms 426, fol. 187r/v: "per salvar che ella sia cometa e non stella. Che io non posso acconsentire che persone dotte alla prima vogliono tener il Cielo coruttibile per poter dir che ella sia una stella."

[4]Cf. BOP, ms 426, fol. 189r; Decembre 31st: "Et i matematici si accordaranno presto fra

There is no need to follow the further development of the debate: evidently, Guidobaldo criticised the "mathematicians" and defended the "philosophers": this critique can be understood only on the basis of the fact, that Guidobaldo considered himself at least partly a philosopher. In fact, also in his mechanical works, he showed respect towards Aristotle and his philosophy – in contrast to the young Galileo or Benedetti. This trait, as we have shown above,[1] was conditioned also by his formation in Urbino and Padua – and made him, the "very great mathematician of his time", as Galileo would have said at the end of the fourth day of his *Discorsi*, take side against the "mathematicians", in favour of the "philosophers".

Keeping in mind this trait of Guidobaldo is necessary to understand certain elements of the *Paraphrasis*: as we will see later,[2] certain topics of its preface appear to be condensation of and reflections on such philosophical discussions.

Guidobaldo's occupation with problems of natural philosophy

Obviously, the *Paraphrasis* is not the only place were Guidobaldo reflected on topics relative to natural philosophy. A letter written to Federico Bonaventura testifies Guidobaldo's occupation with the topic of the flux and reflux of the tides.[3] Both of them apparently disagreed with its treatment in Andrea Cesalpino's *Peripateticarum Quaestionum Libri quinque* (1571).[4] So, the Marchigian mathematician criticised that "it is bad manners for a philosopher to introduce another, even weirder motion of Earth in order to save the motion of the Sea" – Cesalpino had considered the Earth's movement of trepidation the cause of the tides.
Apparently, Guidobaldo's occupation with this subject was part of wider projects: in effect, he exhorted Bonaventura to publish the book[5] he was working on because

> I need to cite them, and I will do so with pleasure, particularly because I have a caprice that Earth does move and this because of Aristotle. But these are things (as You know better than me) that have to be reflected well, and I would not show them around before I will not

loro a chiamarla stella, ma non sapranno però rispondere alle ragioni dei filosofi, che'l cielo sia incorruttibile et non patischi queste novità. Le quali ragioni bisognaria pur solverle se fusse vero che questa cometa fusse stella."

[1] Cf. Part A, II.1.

[2] Cf. Part A, V.2.4.

[3] Cf. Biblioteca Comunale, Forlì, Autografi Piancastelli, 755; December 8th 1588; published by D. Bertoloni Meli, *Guidobaldo dal Monte and the Archimedean Revival*, in "Nuncius", VII 1 (1992).

[4] In the fifth question of the third book – the chapter is entitled *Maris fluxum et refluxum ex motu Tarrae non Lunae fieri*, Cesalpino attributes the reason of flux and reflux of the tides to the motion of trepidation of Earth, negating the influence of the moon.

[5] It is not completely clear to which work of Bonaventura referred here: possibly, the question is about the *De causa ventorum*), in the end published in 1594.

> have the consent of the first philosophers: so that they would make me become aware of my error if there were any, because I confess not to see any. And the more I reflect on it, the more I am sure about it.[1]

In fact, several sources tell us that Guidobaldo had written a treatise *De Motu Terrae* which seems, though, lost.[2] However, an entry in the *Meditatunculae* reveals a part of its content: there, Guidobaldo proved that the displacements of bodies (e.g. in consequence of the construction of a tower) on the surface of Earth entailed that the barycentre of the system Earth-tower is relocated compared to the initial state, and this implies a (practically imperceptible) movement of Earth.[3]

In the *Meditatiunculae*,[4] Guidobaldo attends to problem regarding the resistance of media and the velocities of descent of bodies in a fluid.[5] Thereby, he starts from two premises: the first one is the Archimedean principle, according to which a body's weight in a fluid is diminished by the weight that the equal quantity of water would have; the other one is constituted by the hypothesis, that this phenomenon of buoyancy represents the resistance of the medium opposed to the motion of the spherical bodies: this can be interpreted as deriving from the Aristotelian natural philosophy, as the descend of the bodies is their natural motion which is caused by their gravity. Each effect that diminishes the gravity of a body, like buoyancy, therefore constitutes a resistance to the motion of fall.

Also other phenomena relative to motion – a topic traditionally belonging to natural philosophy – aroused Guidobaldo's interest.[6] A famous counterexample are the experiments on the trajectory of projectiles described on page 236 of the *Meditatiunculae*, most probably carried out with Galileo, as Bonaventura Cavalieri reports.[7]

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[1] Cf. Biblioteca Comunale, Forlì, Autografi Piancastelli, 755: "che so che mi serviranno a me per citarlo et lo farò volentieri, massime che ho un capriccio che la Terra si muova, et questo in via di Aristotele. Ma sono cose che (come Lei sa meglio di me) bisogna prima pensarci bene, e non le lascierei vedere se prima io non avessi il consenso di primi filosofi, acciò mi faccino accorger del mio errore, se vi è, perché io da me stesso confesso che non me ne so accorgere. E quanto più ci penso, tanto più mi ci confermo."

[2] Cf. Appendix I, I.7.3, p. 549.

[3] Guidobaldo's reasoning is exposed in Part A, VI.2.4.

[4] Again, cf. Part A, VI.2.4.

[5] This topic was in vogue in the sixteenth-century: it was treated *inter alia* by Cardano, Benedetti, Moletti, Galileo; cf. p. 102.

[6] This is one of the reasons why the traditional classification of Guidobaldo as "purist of statics" and hostile to the "dynamical tradition" of mechanics represented by Aristotle's and Jordanus's writings, is not really convincing. Certainly, beyond doubt Guidobaldo had a strong preference for Archimedes's approach to mechanics, but he surely did not exclude phenomena relative to motion from study *a priori*. Further, the very use of classifications of "statics" and "dynamics" is problematic if applied to pre-newtonian mechanics.

[7] It is published in *Galileo Opere*, edited by A. Favaro, Vol. XIV (September 21st 1632): "Aggiungo di più che io veramente pensai che in qualche luogo Ella ne avesse trattato, non

V.1.2 The "philosophical" circle around Guidobaldo

The documents exposed in Part A, II.3 reveal the names of some members of Guidobaldo's circle; on this basis, ulterior studies in various archives and libraries have brought to light further biographical information on them: notable is the great diversity of their professions: so, the circle was composed by doctors of jurisprudence (Tiberio Almerici), politicians-feudatories (Count of Carpegna), scholars of history (Omero Tortora), of literature (Curzio Ardizi), of theology (Ludovico Agostini) and, exactly, philosophers (Cesare Benedetti, Federico Bonaventura, Jacopo Mazzoni, Pier Matteo Giordani).
Considering the heterogeneity of this circle formed by noblemen of the Duchy, it is not easy to imagine what they discussed about. We can surely assume that they partly debated on mathematical problems, but moreover there was one common subject they all were familiar with: and this was philosophy, as its study belonged to a nobleman's formation at that time.[1] In effect, Guidobaldo called his interlocutors "philosophers" in a letter in which he invited them to discussions at his feud at Monte Baroccio.[2] This circumstance seems to justify to consider this part of Guidobaldo's environment as distinct from his contacts with architects and engineers, where the discussion on practical problems predominated. So, we might call the circle constituted by the aforesaid interlocutors Guidobaldo's "philosophical circle".[3]

Guidobaldo's interest in philosophy, testimonies of which have been exposed in the last subsection, was shared also by a part of his interlocutors: Cesare Benedetti was a renowned philosopher, teaching philosophy first to Duke Guglielmo Gonzaga of Mantua and then to Francesco Maria II della Rovere – the latter comments in his diary to have read over 15 years all Aristotle's works.[4] Federico Bonaventura was a kind of court philosopher of Duke Francesco Maria II, who dealt with moral philosophy, natural philosophy and astronomy, publish-

avendo'io potuto aver fortuna di vedere tutte le opere Sue; e questo, molto me l'ha fatto credere il sentirla fatta tanto publica e per tanto tempo, che l' <Muzio> Oddi mi disse, dieci anni sono, che'Ella ne aveva fatto qualche esperienza con il Sig.r Guid'Obaldo dal Monte; e questo pure mi ha reso trascurrato in non scriverGliene prima, stimando in realtà ch'Ella punto non si curasse, anzi fosse più tosto per aver grato, che un Suo discepolo, con un'occasione sì opportuna, si mostrasse seguace della Sua dottrina, quale tuttavia confessa aver da Lei imparata."

[1] In this context, it is convenient to keep in mind the general intellectual *milieu* in the Duchy of Urbino, cf. Part A, II.

[2] Cf. BOP, ms 426, fol. 159 r/v: " I wish to invite all you philosophers to favourite me to come and favourite me here above <at Monte Baroccio>." Guidobaldo's letter of August 10th 1588 is addressed to Pier Matteo Giordani; see Appendix II, I.8.3.

[3] Obviously, the term "philosophers" does not precisely correspond to its modern meaning: Baldi, for example, calls Archimedes, Archytas and Eudoxus "great philosophers" in the preface of the *Automata* (fol. 11v). So, a more opportune translation might be "thinkers".

[4] Benedetti further was bishop of Pesaro, from 1586 until 1609.

ing numerous works on these topics.[1] Count Tommaso of Carpegna, encouraged by Bonaventura, attended to the studies on Aristotle's logics and metaphysics.[2] Pier Matteo Giordani discussed with Guidobaldo, as his closest interlocutor and friend, about Aristotle's *Politics*, about the nova of 1604,[3] with Fabio Albergati the difference of the notion *idea* respectively in Plato and Aristotle, and with Baldi about Jacopo Mazzoni's *De Comparatione*. There is no need to mention the important role of the latter, representative of a concordistical approach, especially of the Aristotelian and Platonic philosophies, author of several important works on philosophy and literature, as well as interlocutor of Galileo.
Apparently, this interest in "pure" philosophy was connected also with discussions about natural philosophy, as we have seen in the precedent sections: the debate between Guidobaldo and Bonaventura about the reason of the tides.

A precious hint at connections between Guidobaldo's occupation with mathematics and mechanics and the philosophical interests of his interlocutors is contained in the *Cochlea*. There, the Marchigian mathematician remarks that mathematics and mechanics shed light on phenomena which at first glance seem to be in contradiction with common sense: for example, the existence of bigger and smaller magnitudes than a fixed other one would suggest that it is possible to find a magnitude equal to it. Yet, as geometry shows, this is not necessarily valid, in the case of an angle formed by a line and a circumference: it is either bigger or smaller than a right angle, but never equal to it.[4]
Further, turning to the cochlea, it seems incredible that water, while descending in the device, in reality moves upwards. Guidobaldo's reference to natural philosophy and his philosopher friends is palpable here:

> Who has heard a greater contrariety, not to say contradiction? How can it be accepted that a heavy body freely moves downwards and for this reason goes upwards? Which natural philosopher will ever agree

[1] Some of his writings are: *Anemologia, seu de affectibus, signis et causis ventorum*, *Apologia ... de vero tempore ortus et occasus Orionis*, *Claudii Ptolomaei Alexandrini Geographia*, *Della ragion di Stato*. Futher, G. Mazzucchelli, *Gli scrittori d'Italia*, cit., reports also works on *De aestu maris*, *De calore coeli*, *De via lactea*, *De Themistii paraphrasim*. For further information on Bonaventura, cf. Appendix II, II, "Federico Bonaventura".

[2] Cf. Archivio Carpegna 1 Scavolino 54, Letter August 21st 1586, Bonaventura to Carpegna: "(...) Lodo il pensier di V.S. d'attender agli studi questo verno ma credo bene ch'all'impresa ch'Ella si pone, se per sé stessa altre volte non ne ha avuto lume o cognizione di logica et delle cose dell'anima. Trovarà non poca difficoltà [con] i libri della filosofia morale di Aristotele (...)."

[3] Cf. in this regard V.1.1.

[4] Other examples adduced by Guidobaldo are: it might at first glance seem necessary that two things that steadily get nearer each to each, would meet after a certain time. Yet, as the hyperbole and its asymptotes evidence, this is not true. Finally, mechanics shows how heavy loads can be moved by exiguous forces.

with that? Does not this immediately seem opposed to the senses, to reason, and to the very nature?[1]

Guidobaldo attacks the precedent treatments on the topic as they would not explain the *cause* why the water ascends.[2] This lays bare Guidobaldo's intent once again: apart from describing the *effect* of the cochlea or the circumstances under which it works (as the inclination angle, e.g.), he also is interested in the *cause* why the water, by descending, moves upward. In this approach we might identify the attitude of a natural philosopher.

A text which reflects Guidobaldo's influence and the discussion of his circle is the introduction of Baldi's *Automati*,[3] published in 1589, i.e. practically at the same time as Guidobaldo's *Paraphrasis*.
There are numerous parallels between the topics approached there and the ones of the preface of the *Paraphrasis*. So, like Guidobaldo, also Baldi emphasises that mechanics is composed by the two domains, the natural and the mathematical one:[4] the natural one being under the authority of Aristotle, the mathematical one under the authority of the "Prince of mathematics" Archimedes.[5]
Even if the topic about the "subalternate" sciences was not unusual in mechanical treatises of that period, it is plausible that both Guidobaldo and Baldi refer to their concrete situation at Pesaro, where they debated on mechanical problems

[1] Cf. *Cochlea*, p. 2: "Quis maiorem repugnantiam, ne dicam contradictionem intellixit? Quomodo concedi potest grave aliquod sponte deorsum moveri, et ob id sursum tendere? Quis unquam naturalis philosophus concedet hoc? Non ne statim hoc sensui, rationique repugnare, atque ipsimet naturae contrarium esse videtur?"

[2] Cf. *Cochlea*, p. 4: "Nam fateor quidem omnes de hac cochlea multa dixisse, sed praecipua quaedam, quae ad instrumenti huius cognitionem perfectam pertinere videntur, omnino praetermisisse. Etenum docent quidem, sive potius tantum affirmant (hoc enim sensu percipitur) hoc instrumentum aquam sursum attolli: qua vero ratione id contingat non docent. (...) nemo unquam hanc cochleam, ut eius cognitio expostulat, declaraverit; ac non solum: non declaraverit, sed (quod ipse viderim) nec artificium, quod in ipsa inest, cognoverit, nullum enim prospectum habetur, eius ignorata causa."

[3] B. Baldi, *Di Herone Alessandrino degli Automati*, Venezia, Bentoni, 1589.

[4] Cf. *Automati*, fol. 4r/v: "Vi è quella parte <delle discipline subalterne alla matematica>, o spetie di loro, che ha preso il nome dalle machine et si chiama Mechanica o Machinativa, avvenga che non sempre le dimostrationi matematiche versino intorno agli accidenti proprii delle quantità separate dalla materia: ma talor' anco s'adattino a soggetti sensibili, e dimostrino le meraviglie d'alcuni effetti che accaggiono in loro. (...) // percioché, se bene il suggetto è fisico, sono dimostrate per forza di ragioni matematiche: la onde matematiche sono, in quanto la dimostratione; e naturale, in quanto s'aspetta al suggetto, come insegnò benissimo il Filosofo <Aristotele> nelli posteriori *Resolutorii* e nel principio de' *Mechanici*."

[5] *Automati*, fol. 7r: "Che quest'arte poi, come io diceva, camini di pari passo con le matematiche, si conosce di qui, che Archimede Principe di tutti gli altri in questa professione fabricò quella maravigliosa sfera, nella quale egli unì i moti del Sole, della Luna, e degli altri cinque erranti."

with philosophers.[1] In this regard, it is convenient to keep in mind the letters which Baldi wrote in the 1580s to Pier Matteo Giordani about these discussions, exposed in II.3.
Like Guidobaldo, also Baldi feels concerned about the reputation of the discipline of mechanics: also the latter emphasises the nobility of mechanics.[2]
Also Baldi's numerous references to philosophical and literary works – he cites works of Aristotle, Plato, Hesiod, Homer etc. – seem to reflect the general interests of the courtly ambiance at Pesaro; similarly his references to the famous local artisans Pietro Griffi, Giovanni Maria Barocci e Bartolomeo Campi are clear references to the technical ambiance. Similarly, Baldi's reflections on the "good and right use of instruments" or the distinction between "arti oneste" (like mechanics and the automati) and "arti diaboliche" (like magic) might suggest an influence by Guidobaldo's ambiance composed by philosophers and scholars of theology.

Also Baldi's *Exercitationes* shows the influence of the philosophical circle around Guidobaldo, as their genesis is connected with one of the circle's members: in fact, as we come to know from the funeral oration to Baldi by Marcantonio Vergilio Battiferri (1617), it was Count Tommaso of Carpegna who commissioned or exhorted the future Abbot of Guastalla to write this comment on the Aristotelian *Quaestiones Mechanicae*.[3] As we have seen before, the Count of Carpegna attended both to studies on mechanics and philosophy, he was interested in philosophy, and was debating on it with F. Bonaventura.

Interestingly, also Mazzoni attended to questions pertaining to mechanics/fortification in *De triplici hominum vita*. This may at first sight seem curious, as it is a philosophical work. Mazzoni therein approaches a systematisation of mankind's knowledge, dividing it in categories belonging to three types of life, namely *vita activa, contemplativa* and *religiosa*. But a plausible explanation of this fact is Mazzoni's acquaintance with the ambiance of the Urbinate court, and especially Guidobaldo's philosophical circle. So, in the part on "active life", Mazzoni dedicates some 40 pages to questions relative to fortification and to military organisation – one of the topics that interested the courtly ambiance, as we have seen

[1] Although Baldi stayed at Guastalla in the 1580, his letters (also those exposed in II.3) document that he sometimes turned to Pesaro and met his interlocutors.

[2] Cf. *Automati*, fol. 11v: "Nobili dunque per se stesse sono queste arti <meccaniche>, ma ignobilitate dagl'accidenti, che dicevamo; et della nobiltà loro potiamo accorgerci di qui, che l'invention loro è antichissima, et antichissima la riputatione."

[3] M.V. Battiferri, *Orazione funebre in lode di Monsignor Bernardino Baldi Abbate di Guastalla*, Urbino, Corvini, 1617; p. 17: "le *Questioni mecaniche* ch'ad istanza del Conte Thomasso Carpegna allora giovane, e Signore vago di simili studii, egli compose, nelle quali considerò la diffinitione del centro di gravità de' piani e de' sollidi, e delle proportioni". It is not completely cleared, when Baldi began to work on this task, but a period between 1582 and 1585 is considered as plausible, cf. E. Nenci's introduction of B. Baldi, *In mechanica Aristotelis problemata Exercitationes*, vols. 2, Milano, Angeli, 2010.

in Part A, II.1. In fact, the work was published in 1576, after Mazzoni's sojourn of several months at the Urbinate court in 1574/75, when he had been accommodated by the dal Monte family, contemporaneously teaching philosophy to Duke Francesco Maria II della Rovere.[1]
Mazzoni approaches questions like which form cities should present, if the towers of the city walls should be round, which angle should be formed by the bulwarks, where should be located the city walls etc. As far as the organisation of soldiers and battles is concerned, he treats how the hierarchy of an army should be, how to cross a river, and speaks about several battle formations, both for naval battles and battles on land. In the course of this exposition, he cites a consistent number of ancient and contemporary sources, like Caesar (e.g. on the fortifications of the Germanic tribes), Herodotus (on the Egyptians' fortifications), Polybius (on the forms of camps) and Vitruvius (e.g. on the form of the towers) on the one hand, and like Tartaglia (on the form of the bulwarks), Dürer (on the forms of the citywalls and Leon Battista Alberti (on the city gates) on the other.

V.2 The first book of the *Paraphrasis*[2]

For a long time, almost the entire focus on Guidobaldo's mechanical work was directed to the *Mechanicorum Liber*.[3] Nevertheless, even if the *Paraphrasis* ad-

[1] In effect, in the preface (*Candido Lectori*), Mazzoni thanks Duke Francesco Maria II and the family dal Monte for their help. Cf. p. iii (not numbered): "Namque fortunae coelum illud mihi prius densissimis nubibus nebulisque obtectum iisdem discussis, atque disiectis Francisco Maria Metaurensium amplissimo Duce, tanquam clarissimo Sole me suavissime recreavit, qui cum in familiae suae obsequia me retulisset, deincepts omni genere magnificentiae, atque animi magnitudine in me fuit adeo liberalis, ut iam mihi res meae non modo supra spem, verum etiam supra vota succedere inciperent (...)."; and p. iv (not numbered): "Omitto praeterea quanta mihi hoc tempore sedulo, quanta officio se fecerit Rainerius e Marchionibus Montis, totaque illius familia. Prae omnibus aetem Franciscus Maria Rainerii filius, iuvenis omnibus fortunae, corporis, animique dotibus cumulatissimus, qui multis ab hinc annis quod vegetis, vigilantibusque oculis in studiis exploraverat mecum partiri consuevit, tot tantisque beneficiis est me persecutus, ut si iam id agendum sit, quod et bona nomina facere solent, quibus quando non est unde debitum reddant, saltem apud creditorem quantum debend profitentur, haec tota epistola, aliaeque permultae in hoc erunt consumendae."

[2] Since the second book of the *Paraphrasis* essentially deals with mathematical and not mechanical objects and topics, e.g. conical sections, we confine ourselves to analysing the first book, given that the present chapter refers to Guidobaldo's mechanics.

[3] Welcome exceptions are the following, recent studies on the *Paraphrasis*: M. van Dyck, *Gravitating towards stability: Guidobaldo's Aristotelian-Archimedean Synthesis*, in "History of Science", XLIV (2006), pp. 373-407; M. van Dyck, *«Argumentandi modus huius scientiae maxime proprius». Guidobaldo's Mechanics and the Question of Mathematical Principles.*, in A. Becchi, D. Bertoloni Meli, E. Gamba, *Guidobaldo del Monte (1545-1607). "Mathematics" e technics from Urbino to Europe*, Proceedings of the Guidobaldo-dal-Monte-Workshop Pesaro-Mombaroccio 2007, Berlin, Edition Open Access, 2012; M. Frank, *Das erste Buch der* In duos Archimedis aequeponderantium libros Paraphrasis *von Guidobaldo dal Monte*, Master-thesis, Ludwig-Maximilians-Universität München, 2007.

mittedly did not have its immense impact on sixteenth and early seventeenth century mechanics, it is an interesting text that merits close attention. The essential lack of interest surely was connected to the reductive interpretation of the work, so far almost exclusively considered as manifestation of Guidobaldo's attempt to complete Commandino's work and to let revive Archimedes's writing *Equilibrium of Planes*.
However, as the present section evidences, at least two other fundamental aspects of Guidobaldo's treatise can be identified, besides his goal to furnish a reliable version of the principal work of Archimedean mechanics: the defence of his own theory of indifferent equilibrium,[1] that had been critiqued since the publication of the *Mechanicorum Liber*; and finally the integration of Archimedes's mechanics in a philosophical framework,[2] which seem connected to Guidobaldo's philosophical discussions in Pesaro. To each of these aspects, as well as to the interesting preface,[3] will be dedicated a respective subsection.

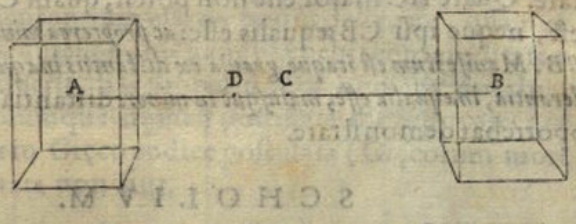
With the *Paraphrasis*, Guidobaldo attended to restore the integrity of the *Equilibrium of Planes*, Archimedes's principal work of mechanics.[4] The corrupted text presented Guidobaldo with problems of essentially three kinds: minor technical problems, like missing argumentative steps in the demonstrations; completely inconclusive demonstrations that requested a massive intervention in the text with lemmata or auxiliary propositions; and, most seriously, obscurities regarding the key notions of Archimedean mechanics.
Approaching this challenge, Guidobaldo adopted a quite "philological" *modus operandi*: firstly, to establish a correct text, he had recourse to the Greek version of the *editio princeps*,[5] which appeared to him less corrupt than the existing Latin translations.[6] In the course of the *Paraphrasis*, he indicated Greek passages which did not seem to make sense and recommended more reasonable wordings in these situations. For example, in the scholium after the third proposition he comments (p. 41):

> In propositione verba illa "maius quidem ex minori" non habentur integra in codice graeco, qui sic habet καὶ τὸ ἀπὸ τοῦ ἐλάσσονος ubi

[1] Cf. subsection V.2.3.
[2] Cf. subsection V.2.4.
[3] Cf. subsection V.2.2.
[4] A short overview on the work and, more generally, Archimedes's mechanics is exposed in Part A, III.2.
[5] The *editio princeps* was published in 1544 at Basel and edited by Thomas Gechauff (Venatorius).
[6] Cf. *Paraphrasis*, p. 7: "Et quamvis opus hoc fuerit ab Autocio Ascolonita nonnullis commentariis illustratum, quia tamen propter Archimedis scriptorum obscuritatem multa adhuc remanent abstrusa, nec prorsus omnibus pervia. Praesertim graecarum litterarum expertibus, cum liber hic in latinum versus multis in locis obscurus, aliisque plerisque quodammodo mancus merito suspicetur, ita ut adhuc in tenebris iacere videatur. *Graecusque praeterea codex impressus, quem secuti sumus*, multis in locis aliqua correctione egere videatur, idcirco ab huiusmodi munere praestando desistere noluimus." The emphasis is ours.

PROPOSITIO. IIII.

Si due magnitudines æquales non idem centrũ grauitatis habuerint, magnitudinis ex vtriſque magnitudinibus compoſitæ centrum grauitatis erit medium rectæ lineæ grauitatis centra magnitudinum coniungentis.



Sit quidẽ A centrũ grauitatis magnitudinis A. B uerò ſit cẽtrũ grauitatis *magnitudinis B. iunctaquè AB bifariam diuidatur in C. dico magnitudinis ex utriſquè magnitudinibus compoſitæ centrum* grauitatis *eſſe punctum C. ſi. n. non; ſit utrarumquè magnitudinum AB centrum grauitatis D, ſi fieri põt. Quòd autem ſit in linea AB, præoſtenſum eſt. Quoniam igitur punctum D cẽtrũ eſt grauitatis magnitudinis ex AB cõpoſitæ, ſuſpẽſo põcto D,* magnitudines AB *æqueponderabunt. magnitudines igitur AB* æquales *æqueponderant ex diſtantiis AD DB* inæqualibus exiſtentibus; *quod fieri non poteſt. æqualia. n.* grauia *ex diſtantiis inæqualibus non æquepõderãt.* Nõ eſt igitur D ipſarũ magnitudinũ cẽtrũ grauitatis.. *Quare manifeſtum eſt punctum C centrũ eſſe grauitatis magnitudinis ex AB compoſitæ.* quod demonſtrare oportebat.

def. centri grauit. contra 2. poſt huius

2 poſt huius.

SCHOLIVM.

Poſſunt magnitudines æquales idẽ centrũ grauitatis habere, vt duo parallelogrãma æqualia ad rectos ſibi inuicẽ angulos exiſtentia: triãgulũ quoque & parallelogrãmũ interſe æqualia. põterea cubos, piramides, cylindros, & nuiuſmodi alias magnitudines æquales idẽ grauitatis cẽtrũ hẽre intelligere poſſumus. propterea in propoſitione cùm inquit Archimedes *ſi duæ magnitudines æquales non idem centrum grauitatis habuerint.*

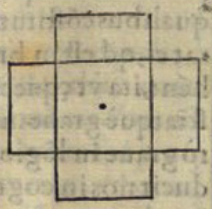


Figure V.1: A page of the *Paraphrasis*: clearly distinguishable the different fonts used by Guidobaldo in the demonstration, in order to indicate Archimedes's original text in contrast to his own explicative additions. Each proposition moreover is followed by a scholium with explications regarding linguistic, mathematical or conceptual aspects of the antecedent theorem.

> disiderari videtur μεῖζον, ut integre ita legatur καὶ τὸ μεῖζον ἀπὸ τοῦ ἐλάσσονος.
> "*Sitque maius A*": Graecus codex καὶ ἔστω το A, ubi similiter supplendum est καὶ ἔστω μεῖζον τὸ A. Haec vero ita sunt omnino restituenda, quia in ultima demonstrationis conclusione inquit Archimedes "*Manifestum est itaque gravia ex distantiis in aequalibus aequeponderantia inaequalia esse, maiusque in minori existere*".

Moreover, Guidobaldo reports every single word of the Archimedean treatise, clearly distinguishing them, by using different fonts (cf. figure V.1), from his own additions and explications. These are either inserted in the text of the demonstrations (if necessary for the understanding), or reported after the propositions: in fact, each proposition is followed by a scholium containing explications of linguistic, mathematical or conceptual nature. If a demonstration lacks a crucial element or does not motivate a relevant step, Guidobaldo inserts lemmata to prove the missing assertions.
With this system, the most interesting information obviously is contained, except for the preface, in the scholia: it is there that Guidobaldo can give utterance to his ideas and remarks regarding both Archimedes's and *his own* ideas.[1]

V.2.1 Overview of the content

After a short dedicatory letter,[2] an ample 21-pages preface initialises the work. This by far most lengthy introductory part of all Guidobaldo's works contains several noteworthy elements, which we will expose in V.2.2.
Guidobaldo adopts a numeration of the postulates that does not correspond to Heiberg's in the critical edition.[3] He comments each of them, coming to speak about the type of balance probably considered by Archimedes, about the Syracusan's possible inspiration from the *Quaestiones Mechanicae*, about the concept of "*similar positioned*" of points in geometric figures or about the convex envelop of figures in which the barycentre has to lie.[4]

[1] In fact, Guidobaldo uses the occasion of the scholia for ample digressions and discussions: for example, in the scholium after the forth proposition (7 pages (!)), the preliminary comment to Proposition VI (the law of the lever; 6 1/2 pages), the comments before and after the seventh theorem (3+2 pages) and a paragraph after Proposition XV (5 1/2 pages).

[2] The dedicatory letter is very important, as it reveals the connection of the work with the *Mechanicorum Liber*. A summary is given in V.2.3.

[3] Probably, this is due to the fact that in the Greek text of the *editio princeps* (1544) the postulates are unnumbered and reported in a continuous text without paragraphs. So each phrase of the postulate-block corresponds in Guidobaldo's translation to an autonomous axiom.

[4] The scholium after the eighth axiom shows a rarity: Guidobaldo committed an error of translation: he translates the Greek "Εἴ κα μεγέτεα ἀπό τινων μακέων ἰσορροπέωντι" as "magnitudes from equal distances" ("*magnitudines ex aequalibus distantiis*"), whereas it must be "from any, arbitrary distances" ("*ex quibusdam distantiis*"); obviously this error does not have any grave consequent for the argumentative structure. Cf. M. Frank, *Das erste Buch der*

The first three Archimedean propositions which prove a qualitative version of the law of the lever did not require much comment. Their function, according to Guidobaldo, was a sort of didactic introduction of Propositions IV-VII, which expose and demonstrate the law of the lever in the *quantitative* version.[1]
Proposition IV, claiming that the barycentre of two equal magnitudes divides in two halves the line linking their centres of gravity, is lengthily commentated by the Marchigian mathematician; in seven pages he discusses five important aspects connected to this theorem: firstly, he dwells on the concept *composed magnitude*,[2] invoked by the proposition: it is this Archimedean conception that permits to consider the connection of weights – in this case the balance – as a new, autonomous body, just as a new physical entity, with a defined, unique barycentre. Secondly, he explains the connection of the concepts *aequeponderare* and *centre of gravity*, according to Guidobaldo an important "*argumentandi modus*":[3] here, again, Guidobaldo correctly identifies a crucial element of the Archimedean mechanics which, in its transmitted form, does not define or specify the properties of these two notions. In effect, in the forth proposition of the *Equilibrium of Planes* there is a hint of their connection: a body/magnitude, held in its centre of gravity, equiponderates, according to a passage contained in the prove of the theorem.[4] Thirdly, he attempts to give a closer description of the concept *equiponderation*, the analogue of the Greek ἰσορροπία used by Archimedes. His

Paraphrasis, cit.

[1]Not that, according to Berggren these propositions are spurious, cf. J.L. Berggren, *Spurious Theorems in Archimedes' Equilibrium of Planes Book I*, cit.

[2]Guidobaldo rightly considers this aspect as crucial both for Archimedes's as for his own theory: in effect, the approaches of Aristotle and Jordanus do not contain this conception. The latter, for example, did not regard the balance as a body as an own "physical entity", but regarded the two weights on the balance separately, testified by his consideration of *two*, hypothetical descents of the weights. In the *Equilibrium of Planes*, in contrast, Archimedes considers the balance abstractly as a body *per se*, attributing to it one and only one centre of gravity and consequently applying his theory. Guidobaldo used the same strategy for his theory of indifferent equilibrium: in his opinion, an inclined isostatic balance could be regarded as a normal (mathematical) body with a barycentre and ceased to move as soon as it was held in that point. So Guidobaldo deals here with the question why Archimedes is "allowed" to consider two weights and a beam in between as one *unique* body (and consequently he himself, too).

[3]"*Argumentandi modus*" could be rendered with "argumentation principle": they were importance, according to Guidobaldo, to comprehend Archimedes's argumentations. Most of them refer to the conceptual relations between the Archimedean basic notions *aequeponderatio*, *centre of gravity* and *equilibrium*. A more detailed analysis is exposed in Part B, chapter II; particularly in subsection II.4.2; another interesting study on this topic is M. van Dyck, *«Argumentandi modus huius scientiae maxime propius»: Guidobaldo's Mechanics and the Question of Mathematical Principles*, in *Guidobaldo del Monte (1545-1607). "Mathematics" e technics from Urbino to Europe*, cit.

[4]Part B, I.5 and particularly Part B, chapter II deal with this question thoroughly: it is a relevant aspect of the reconstruction of Archimedes's mechanics and of Guidobaldo's own theory of *proto-moment*.

statements in regard are precious to comprehend Guidobaldo's theory of *proto-moment* and are analysed in Part B, chapter II. Fourthly, he tries to justify the lack of an argumentative step, namely the fact, that the centre of gravity of a magnitude composed by two other figures lies on the line connecting its centre of gravity. Interestingly – and this is somewhat emblematic – he tries to find a justification of this statement in the precedent passages of the treatise, without taking (or not wanting to take?) into consideration the possibility of the treatise's corruption. Fifthly and finally, he explains the terminological incoherency in the denomination of the regarded objects as "gravia", "magnitudines" and "figurae". This depends, according to Guidobaldo, on the different properties of the objects in question that Archimedes wants to use: "weight" when their physical properties are concerned, "figurae" and "magnitudes" when their geometrical properties, like the position of the barycentres in a figure or the fact of divisibility, are at the forefront of the argumentation.

After the fifth proposition and its corollaries, which make statements about systems of equal weights and their barycentre, Guidobaldo prepares the demonstrations of Propositions VI and VII, i.e. the law of the lever for commensurable and incommensurable magnitudes. This required a intensive intervention, since particularly the seventh proposition is heavily damaged. First, he proves a short lemma on a common measure of two magnitudes in ratio 1:2, necessary for the theorem on commensurable magnitudes. He then comes to speak about the substitution of weight-systems with the same gravity and barycentre position, having it correctly identified as the key idea of the Archimedean demonstration of the law of the lever for commensurable magnitudes.
Guidobaldo explains that such substitutions are legitimate and do not change the mechanical situation of the system (cf. figure V.12).[1] With this explication, Guidobaldo approaches to comment of the sixth proposition, whose demonstration precisely consists in the substitution of the initial weights in an equivalent system of regularly arranged small weights. The barycentre of this last system is shown to divide the line between the initial weights in the inverse ratio of their gravities. For the equivalence of the two mechanical situations, the law of the lever is proved.

[1]Interestingly, Guidobaldo here has identified exactly the point that about three centuries later was criticised by Ernst Mach as implicit supposition of the hypothesis. Yet, Guidobaldo's justification is convincing (p. 56): "Si igitur intelligatur potentia in E sustinere pondera BC, hoc est pondus ex ipsis BC compositum, pondera utique manebunt. Quod si ambo pependerint ut quinquaginta, potentia in E tantum quinquaginta sustinebit. Quoniam totum sustinebit pondus ex ipsis compositum. Auferantur vero pondera BC a situ BC, intelliganturque pondera esse in E constituta, hoc est unum sit pondus ex ipsis simul iunctis compositum, cuius centrum gravitatis sit in E constitutum; tunc eadem potentia in E eodem modo hoc pondus sustinebit; propterea quod eodem modo quinquaginta tantum sustinebit. Quare pondera BC tam ex distantiis EC, EB gravitant, quam si utraque in E constituta fuerint; vel quod idem est, quam pondus ipsis BC simul aequale in E positum."

To restore the mathematical integrity of the seventh proposition, Guidobaldo has to prove another lemma and an auxiliary proposition. The lemma shows that, given two incommensurable magnitudes, it is possible to take away from the bigger one such a part, that it remains bigger than the smaller, but results commensurable to it. The proposition proves that, if the ratio of two commensurable magnitudes A to B is smaller than that of their distances ED to EF from the fulcrum E, so in F has to be placed a magnitude bigger than A to establish equilibrium. With this preparation, Guidobaldo is able to fill the logical lacunae of the demonstration of Proposition VII. Then, immediately afterwards, he proves the theorem with an aliter: instead of referring the commensurability to the magnitudes (i.e. weights), he refers it to the distances of the weights to the fulcrum. For this purpose, he antecedently demonstrates the analogue of the auxiliary proposition in terms of distances (i.e., with the same denominations of above, the weight A has to be situated in a point G with $EG > EF$).
Proposition VIII does not require any intervention by Guidobaldo.

The Marchigian mathematician places in front of Proposition IX, which proves the barycentre of the parallelogram to be the intersection of the lines linking the midpoints of its opposite sides, a lemma on a parallelogram, divided in several small, congruent parallelograms. Proposition X and its aliter, which show the parallelogram's barycentre to the intersection of the diagonals, do not need any greater explanation by Guidobaldo; nor do Propositions XI and XII, which make statements on similarly positioned points in the triangle. The thirteenth theorem, on the contrary, requires some preparations: first two lemmata regarding technical details of the Theory of Proportions, and another one on a certain way of inscribing parallelograms in a triangle.

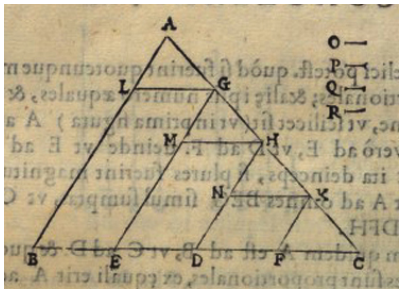


Figure V.2: The third lemma preceding Proposition XIII: the whole triangle is to the "sum" of the small ones as AC to AG.

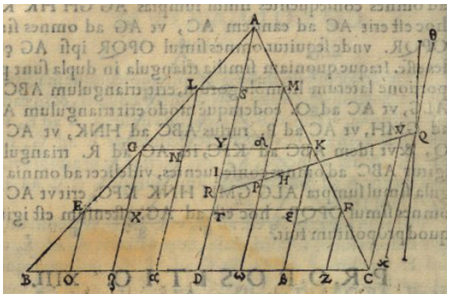


Figure V.3: Proposition XIII: the determination of the triangle's barycentre.

In fact, in Proposition XIII, where the triangle's barycentre is shown to lie on the meridian, Archimedes considers a triangle whose basis is divided in equal

parts of a certain length. From the division points of these parts, parallels of the meridian are drawn which intersect the two other sides of the triangle. The connection lines of the respective intersection points are parallel to the basis (cf. figure V.3). Now, by this procedure the triangle is divided in two parts constituted on the one hand by several small parallelograms and on the other hand by some small triangles. The third lemma, inserted by Guidobaldo before the proposition, shows that the "sum" of the small triangles is to the whole triangle as one of the equal basis subdivisions to the whole basis (cf. figure V.2). This was stated in the proposition without demonstration. The aliter of the thirteen proposition does not require any substantial intervention by Guidobaldo.
Proposition XIV states that the centre of gravity of a triangle is the intersection of the meridians. As its demonstrations confines itself to the consideration of two meridians, Guidobaldo shows afterwards that also the third meridian passes through the intersection point of the other two. Further, he proves that the centre of gravity divides the meridian in the ration 2:1. The Proposition XV, about the barycentre of the trapezium, does not need greater interventions.

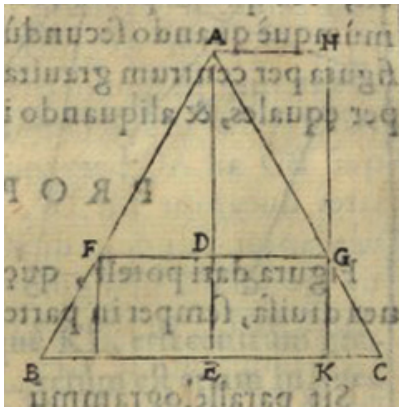


Figure V.4: The triangle ABC is divided in two parts AFG and $BCGF$ of different area by the line FG passing through its barycentre D.

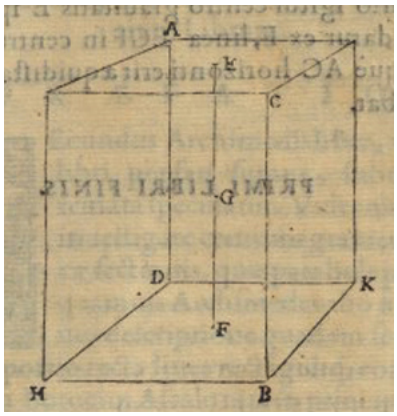


Figure V.5: The knowledge about the barycentres of planes helps to determine those of solids, as exemplified by the prism.

The conclusion of the first book is constituted by a serious of problems and propositions that Guidobaldo adds on his own. First, he shows that with Archimedes's results the barycentre position of every rectilinear figure can theoretically be found, by decomposing it into triangles.
Then he adds two propositions on the division of figures by lines passing through their centres of gravity: firstly, he shows that there are figures, like the parallelogram, which are divided always in two equal parts by any line passing trough the barycentre. Then, he proves that certain other figures, like the triangle, are *not* necessarily divided in two parts of equal area (cf. figure V.4). These problems

seem to go back to reflections deriving from Guidobaldo's interaction with his technical-scientific ambiance (cf. Part A, IV.1.2). Finally, Guidobaldo revisits a topic delineated in the preface: the knowledge about the barycentres of plane figures can be used for the determination of the centres of gravity of prisms having the basis and the top constituted by a plane figure with known barycentre: it is sufficient to divide the connection line of these barycentres in two halves, and the division point is the centre of gravity of the prism (cf. figure V.5).

V.2.2 The preface

The preface of the *Paraphrasis* takes a special position in Guidobaldo's work: with 21 pages, it covers more space than any other – a comparison: the preface of the *Mechanicorum Liber* covers half the space, with even less lines (27 instead of 37); the preface of the *Cochlea* is even shorter. Another peculiarity regards its content: as early as in the preface, Guidobaldo approaches central elements of the main part, such as the properties of the *centre of gravity*.
These twenty-one pages offer precious information about Guidobaldo's conception of mechanics and natural philosophy. This is the reason why we attend to a detailed description of its content in the present subsection.

Guidobaldo introduces the preface with a repetition and transposition of the wonder-motif exposed in the *Quaestiones Mechanicae*: mechanics deals with effects that provoke wonder; the ignorants' by contemplating the effects, the learned scholars' by considering their causes. Particularly astonishing are phenomena produced by human invention (*ars*) which seem to happen against nature (*praeter naturam*).[1] According to Aristotle's *Physics* and *Quaestiones Mechanicae*, they would relate to each other in three different ways – the human intervention imitates nature (e.g. sculpture); human intervention fulfils what nature cannot (e.g. medicine); human intervention outmatches nature. Yet, as Guidobaldo emphasises, this contrast between *natura* and *ars* is only pretence: in reality, human invention imitates nature *always*.[2]
This is illustrated by mechanics, for example by the lever – the part of mechanics

[1] *Paraphrasis*, pp. 1-2: "Mechanica facultas non solum ab imperitis, verum etiam ab eruditis admirabilis semper habita fuit. Eorum enim, quae in admirationem homines trahunt, duo esse genera Aristoteles in principio suarum *Quaestionum Mechanicarum* asseruit: Quorum sane alterum ad ea pertinet, quae natura quidem proximis tamen ipsorum causis latentibus in lucem prodeunt. Alterum vero spectat ad ea, quae prater naturam et arte fiunt. (..//..) Ut tum imperitis ex ipsorummet effectuum intuitu, tum eruditis in causarum varia contemplatione admirationem pariat."

[2] *Paraphrasis*, p. 2: "Ars quippe ex Aristotele *Physicorum* secundo <libro> et ex prooemio *Quaestionum Mechanicarum* triplici modo in suis opificiis sese habere videtur. Nam vel immitatur naturam; vel ea perficit, quae natura perficere non potest; vel denique ea, quae praeter naturam fiunt, operatur. In quibus tamen omnibus operandi rationibus, si diligenter eas consideremus, artem semper immitari naturam perspiciemus."

that deals with weights, distances and equilibrium anyway is the most important one: certain weights be fixed at the endpoints A, B of a lever; the barycentre of the system be in C and the lever be sustained by the fulcrum in D (cf. figure V.6). So the barycentre, not being sustained, moves downwards, provoking that the weight in A moves upwards. So, despite of this unnatural movement (*praeter naturam*) of a heavy[1] body upwards, it follows the natural laws which entail this movement as consequence of the movement downwards of the barycentre C and of the weight in B.[2]

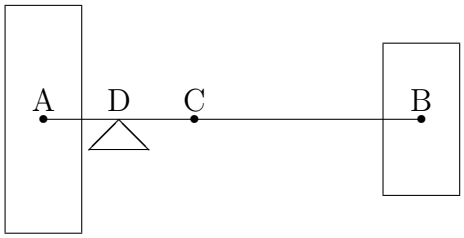


Figure V.6: The movement upwards of the *heavy body A* as example of a "natural" process *praeter naturam*.

So, what does the human intervention effect? Nothing else than arranging the situations according to mankind's demands and utilities.[3]

The successive change of subject brings Guidobaldo to talk about the relation of Aristotle and Archimedes. At first sight maybe somewhat unexpectedly, Guidobaldo considers their mechanical work practically equipollent: Aristotle, in the *Quaestiones Mechanicae* would have revealed many things necessary to comprehend the causes of mechanical phenomena; and Archimedes, following the Stagirite, furnished on this basis a more detailed analysis of the mechanical principles.[4] But this does not diminish Aristotle's merit: he had revealed the *causes*

[1] "Heavy" in the sense of the Aristotelian natural philosophy.

[2] *Paraphrasis*, p. 3: "Sed su B deorsum movetur, A certe sursum elevabitur, quippe quod, quamvis, ut grave est, atque solutum absque connexione ponderis B deorsum tenderet. Attamen ut adnexum ponderi B, intercedente vecte AB, sursum movebitur: et (ut ita dicam) pondus A contra propriam naturam naturaliter ascendet. Unde perspicuum est hos motus effectus esse naturales."

[3] *Paraphrasis*, p. 3: "Quod igitur efficit ars ipsa? Nil sane aliud, quam quod res ita disponit et accomodat, ut similes effectus inde prodeant atque si naturales omnino exsistant, quare opus erit, ut ars naturam immitetur, siquidem effectus naturales provenire debent. (...) Quorum quidem apparatus sunt artis opera, effectus autem ipsius paene naturae: cum eius momenta, inclinationesque sequantur, veluti praecipuas eiusmodi operum effectrices causas."

[4] *Paraphrasis*, p. 4: "Aristoteles enim in principio *Quaesionum Mechanicarum* multa, eaque praecipua ad causas rei mechanicae dignoscendas aperuit. Quem secutus Archimedes in his libris mechanica principia explicatius patefecit, eaque planiora reddidit."

of many mechanical phenomena and Archimedes gave them a mathematical description.[1]

The fact that Archimedes had followed Aristotle would become clear from at least two facts: first, Archimedes postulates in his axioms what Aristotle has shown in the *Quaestiones Mechanicae*;[2] second, both of them would agree in the conception of mechanics as constituted on the one hand by a mathematical component, and on the other by a part which refers to natural objects and phenomena (*naturalia*). In effect, Archimedes would have considered magnitudes like distances, proportions and so on mathematically, but effects related to the centre of gravity, or the movements upwards or downwards according to argumentations related to nature (*naturaliter*).[3]

Corresponding to this bi-partition of mechanics, there is no doubt, as Guidobaldo emphasises, that Aristotle is the uncontroversial leader of philosophy, including natural philosophy, dealing with objects and phenomena connected with nature; and on the other side, Archimedes is the model for every mathematician.[4] So,

[1] *Paraphrasis*, p. 4: "Nec propterea Aristoteles diminutus exstitit: etenim eorum, quae ab ipso proposita et explicata fuere, problematum causas egregie patefecit. Sed quoniam Archimedi scopus fuit mechanicae disciplinae rudimenta explanare, propterea ad magis particularia enucleanda descendere voluit. Aristoteles enim (gratia exempli) quaerens cur vecte magna movemus pondera. Cuasam esse ait longitudinem vectis maiorem ad partem potentiae: et recte quidem. Cum ex principio ab ipso constituto manifestum sit, ea, quae sunt in longiori a centro distantia, maiorem quoque habere virtute."

[2] In effect, Guidobaldo comments Archimedes's first postulate (p. 24): "Quod quidem ab Aristotele quoque in principio *Quaestionum Mechanicorum* elici potest: idem scilicet pondus longius a centro gravius esse eodem pondere ipsi centro propinquiori. Unde si duo essent pondera aequalia alterum altero propnquius centro, quod emotius est, gravius altero appareret. Si igitur gravia aequalia a centro aequaliter distabunt, aequegravia erunt ac propterea aequeponderabunt: quod quidem supponit Archimedes." In the scholium of the second postulate, Guidobaldo is even more explicit: "Supponit autem Archimedes hoc postulatum respiciens fortasse ad ea, quae Aristoteles idem pondus celerius ferri, quo magis a centro distat, vel quod idem est, duo pondera aequalia inaequaliter a centro distantia, quod magis distat, celeius ferri."

[3] *Paraphrasis*, pp. 4-5: "Quare Archimedes Aristotelem sequi videtur. Quod non solum patet ex iis, quae dicta sunt, verum etiam si Archimedis postulata consideraverimus, quibus constituendis, ea, quae de principiis mechanicis Aristoteles patefecit, Archimede supponere comperiemus, ut deincepts suo loco perspicuum fiet. In ratione praeterea, ac modo considerandi mechanica, maxima ambo affinitate coniuncti incedere videtur. Aristoteles enim res mechanicas tum mathematica, tum naturalia sapere, ac respicere asseruit. Quod quidem et Archimedes optime novit: nam quae mathematicae sunt consideranda, geometrice demonstravit, ut sunt distantiae, proportiones et alia huiusmodi. Quae vero sunt naturalia, naturaliter quoque consideravit, ut ea quae ad gravitatis centrum spectant, et quae sursum et quae deorsum move//ri debent et cetera huiusmodi."

[4] *Paraphrasis*, p. 5: "Ex quibus patet maximum esse inter tantos viros in his pertractandis consensum. Ambiget fortasse quispiam, nunquid haec principia recte ab illis fuerint pertractata? Sed statim omnis cessat dubitandi occasio, si tantorum virorum praestantia ad memoriam revocetur. Quibus, citra controversiam in disciplinis ab ipsis traditis, omnes eruditi palmam deferunt. Ut quemadmodum absque Aristotele duce atque doctore nemo ad recte philosophandum, ita neque etiam ad mathematicam, praecipueque mechanicam disciplinam absque Archimede sese quipiam disponere possit. Quorum sane apud peritiores authoritas merito ob

who is eager for science, has to follow those two and must read their writings thoroughly, diligently and very often.[1]

Guidobaldo now comes to speak about Archimedes and his marvellous inventions: the way to measure the amount of gold contained in the crown of king Hieron; its orrery which represented the motion of the planets; the crane with which he lifted ships; or the devices for the defence of Syracuse during the Romans' siege.[2] However, despite of these extraordinary inventions, another part of his activity would be by far more relevant: namely his writings, above all *On the Sphere and Cylinder* and the *Equilibrium of Planes*.[3]
The latter work unfortunately would not yet be available in a reliable version, despite of Eutocius's comment, which would not prevent that many passages remained obscure.[4] So Guidobaldo did not want to renounce to help the scholars of mechanics by commenting on this work. In fact, it would offer the safe access to mechanics.[5]

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id suprema exstat, quod ab ipsis res eo meliore, praestantioreque modo pertractatae fuerunt, quo ipsarum rerum natura aeque doctrinae ratio postulabat."

[1] *Paraphrasis*, p. 5: "Et qui scientiarum cupidi sunt, illos sequi, eorumque scripta saepe saepius attente perlegere debent."

[2] *Paraphrasis*, p. 5: "Etenim si ea, quae mathematica ope indigent, laudare volunt, ad Archimedem confugiendum est; ut si inventionem, subtilissimum Archimedis inventum afferant, quo modum adinvenit cognoscendae quantitatis argenti, quod erat in corona regis aurea, ut Vitruvius testatur, et alia huiusmodi. Si admirabilia, statim afferant Archimedis sphaeram in globo vitrea elaboratam, in qua omnes caelestis sphaerae motus relucebant, ita ut natura potius Archimedem immitata, quam Archimedes naturam illusisse videatur; navem praeterea gravi pondere oneratam e mari in litus ab Archimede eductam, aliaque id genus plurima. Denique si res mathematicae civitatibus esse utiles ostendere volunt, ea quae ab Archimede contra Marcellum in defensione patriae facta fuere, in medium afferant (...)."

[3] *Paraphrasis*, p. 6: "Sed nonnulla egregia exstant ipsius Archimedis opera, quorum similia nec antea, nec post isum facta fuere, neque in futurum facienda fore a nemine sint expectanda: omnium enim admirabilissima praestantissimaque sunt eius scripta, in quibus et ingenii acumen, inventiones subtilissimae, perfectaque doctrina plane conspicitur. Adeo enim his omnibus Archimedis scripta aliorum scripta mathematicorum excellunt superantque, ut quae aliorum, facile quidem inter sese comparari, cum iis vero, quae ab Archimede nobis relicta fuerunt, nullo modo possint. Ut apertissime (aliis interim omissis) conspicuum redditur ex iis, quae *De Sphaera et Cylindro*, et ex iis, quae *De Aequeponderantbius* scripta reliquit: quippe quae ob eorum praestantiam ac dignitatem merito litteris aureis essent imprimenda."

[4] *Paraphrasis*, p. 7: "Et quamvis opus hoc fuerit ab Eutocio Ascalonita nonnullis commentariis illustratum, quia tamen propter Archimedis scriptorum obscuritatem multa adhuc remanent abstrusa, nec prorsus omnibus pervia. Praesertim graecarum litterarum expertibus, cum liber hic in latinum versus multis in locis obscurus, aliisque plerisque quodammodo mancus merito suspicetur, ita ut adhuc in tenebris iacere videatur. Graecusque praterea codex impresus, quem secuti sumus, multis in locis aliqua correctione egere videatur, idcirco ab huiusmodi munere praestando desistere noluimus."

[5] *Paraphrasis*, p. 7: "Et ne quipiam, quod studiosis mechanicae facultatis prodesse possit, praetermitteretur, ad horum Archimedis librorum interpretationem aliquid operis contulisse placuit. (...) Quin simul hos libros in latium sermonem verteremus, commentariisque illustratos redderemus, cum praesertim hinc tutus ad mechanicam disciplinam pateat aditus."

Now, he shortly hints to the method adopted by paraphrasing the Archimedean treatise: instead of adding comments at the end of the respecting demonstrations – as Commandino had done, for example -, he inserted his comments, indicated by the use of a different font, in the middle of them. And between the single propositions he integrated scholia or lemmata, which explain relevant elements of the precedent or successive theorems.

Essential for the comprehension of the *Equilibrium of Planes* would be the knowledge of the properties of the concept *centre of gravity*. In fact, as in the *Mechanicorum Liber* Guidobaldo adduces two definitions for it, the one exposed by Pappus in the eighth book of the *Collectiones Mathematicae* and the one of Commandino from the *Liber de Centro Gravitatis Solidorum*. According to the first one, a body held in its barycentre stands still, while Commandino's states that all parts around it possess equal *moments* and that any plane passing through it divide the body in *equiponderating* parts. Interestingly, Guidobaldo does not wast a word on the notion *moment* – maybe the use of this undefined concept was the reason why he considered Commandino's definition as "rather a description than a definition".[1]
The following paragraph justifies the definition of *centre of gravity* in Pappus's version, with recourse to the Aristotelian conception of the *cosmos*: the basic assumption is that a (in the Aristotelian sense) heavy body is at rest in the centre of the world.[2] Thus, respecting to the point that coincides with the centre of the world, all parts of the body must have equal moments. Otherwise, one part would preponderate compared to another and therefore produce movement; this would be in contradiction to the fact, that every heavy body is at rest in the centre of the world. So, the point coinciding with the centre of the world is, according to Commandino's definition, the barycentre of the body.
Since gravity is the cause of the movement of the heavy body towards the centre of the world, and since, in effect, it is its centre of gravity that would coincide with the centre of the world (if it could get there), so any heavy body can be said to actually weigh exactly in its centre of gravity. Therefore, when a weight is held in its centre of gravity, the weight stays at rest insofar as the cause of its movement, namely gravity, does not act under these circumstances.

In the connection of his considerations on the concept *centre of gravity*, Guidobaldo touches upon two related topics: firstly, a figure divided by the plane passing through its barycentre, is not necessarily divided in two parts with equal

[1] *Paraphrasis*, p. 9: "Hanc postremam definitionem, seu potius descriptionem tradidit Federicus Commandinus in *Libro de Centro Gravitatis solidorum*".

[2] The relative quotations are exposed in subsection V.2.3, where the relevance of this argumentation is highlighted in the light of Guidobaldo's defence of his theory of the isostatic balance.

area. Guidobaldo refers here to the demonstration of this fact, on pages 113/14 of the *Paraphrasis*.[1]
Secondly, besides the centre of gravity, one could consider also other kinds of centres: the centre of the world, and the centres of magnitude and of figure. The centre of magnitude would be the middlepoint of a magnitude, with equal distances to its surface (so it exists only for circles and spheres); the centre of figure is the origin of the semi-diameters of a figure, for example for ellipses.[2]
In just one case, all these centres would coincide (and exist) and that would be for Earth: its barycentre would be situated in the centre of the world, and as Earth is a spherical body, its barycentre coincides with the centres of figure and magnitude.
Further, while the centres of figure and magnitude do not exist for every object, centre of gravity does instead -[3] rather than an axiom, this seems to be the deduction from Guidobaldo's cosmological reasoning. But it would be possible that the barycentre of a figure would lie outside the figure, if one would think of a ring, where the centre of gravity is in the centre of the circle, which is outside of the ring. Yet, considering the convex envelop (modernly spoken), it actually is always inside of the figure and this envelop.[4]

Guidobaldo now turns to the question of the utility of the topics treated in the *Equilibrium of Planes*. Admittedly, at first sight Archimedes's occupation with the barycentres of planes would seem completely superfluous, as there are not such abstract, mathematical objects in reality. Yet, as Guidobaldo emphasises, in contrast, the topic is not far from reality if we interpret the planes as bodies of exiguous height, or if they are considered as the inferior and superior surfaces of prisms.[5] So, the knowledge of their centres of gravity is necessary to deter-

[1] This interesting problem seems to come from a stimulus Guidobaldo had received by the interaction with his scientific environment, cf. Part A, IV.1.2.

[2] *Paraphrasis*, p. 8: "Pro cuius tamen faciliore notitia illud quoque in primis admonendum duximus, nimirum quattuor reperiri centra: videlicet universi, centrum magnitudinis, centrum figurae, et centrum gravitatis." *Paraphrasis*, p. 11: "Centrum figurae apud mathematicos est punctum, a quo semidiametri exeunt; vel per quod transeunt diametri, ut circuli centrum et ellipsis, nec non oppositarum sectionum. Centrum vero magnitudinis est id, quod medium figurae obtinet, cel quod aequaliter ab exteriore superficie distat, ut sphaerae centrum. Centrum denique mundi est punctum in medio universi situm, omniumque rerum infimum."

[3] *Paraphrasis*, p. 12: "nam quodlibet corpus et quaelibet igura necesse est ut habeat centrum gravitatis intrinsecus, vel extrinsecus."

[4] *Paraphrasis*, p. 14: "Cui obiectioni in hunc modum occurri poterit, si dixerimus, quod quamvis exempli gratia in figura C dictum sit centrum gravitatis D extra figuram exsistere, id ipsum etiam intra figuram esse affirmari poterit, siquidem ambitus figurae C centrum D intra se continet, ita ut respectu totius sit intra. Idemque dicentum est de altera figura A. Hoc autem evidentissimum est in figura E. Et hic est sensus definitionum centri gravitatis."

[5] *Paraphrasis*, p. 15: "Et quamvis re ipsa actuque plana seorsum a corporibus reperiri nequeant, in ipsis tamen haec ipsorum circa centra gravitatis aequeponderatio ae actum facile redigi poterit: ut sit solidum AB prisma, cuius latera AE, CF, DB sint horizonti erecta,

mine the barycentres of solids. Correspondingly, Guidobaldo slightly modifies the aforesaid barycentre-definitions so that they refer to planes.
Further, the notion *moment* is not exclusively referring to (in the Aristotelian sense) *heavy bodies*: both Aristotle and Ptolemy attribute moments also to (in the Aristotelian sense) *light* bodies.[1] In effect, the point regarding to which a light body has parts of equal moments, could analogously be called the *centre of lightness*.[2]
Moreover, it would be worth to consider objects independently from the question if they *heavy* or *light*. In effect, scholars of astronomy deal with planets and celestial bodies which are neither *heavy* nor *light*. So why should not it be legitimate to study planes, and to regard them, as it is use in astronomy, neither as *heavy* nor as *light*?[3]
The importance and utility of Archimedes's theory on the barycentres of planes would moreover be evidenced by his writing *Quadrature of the Parabola*, where he found the quadrature of this conical section.[4] And finally, the statement and demonstration of the law of the lever, exposed in the *Equilibrium of Planes*, is so fundamental and fertile that

> I do not flinch from claiming that there is no mechanical theorem or problem whose solution does not base on what Archimedes exposed in this books.[5]

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superiorque basis ACD, quemadmodum et inferior EFB sit horizonti aequidistans. Sit autem plani ACD centrum gravitatis G. Ex quo G si suspendatur totum AB patet planum ACD horizonti aequidistans permanere, ac propterea circa centrum gravitatis G aequeponderare."

[1] Subsection V.2.4 revisits this topic more thoroughly.

[2] *Paraphrasis*, p. 16: "Neque enim Aristoteles gravibus duntaxat, sed etiam levibus momenta tribuit, idipsumque (ut Eutocius in horum librorum comentariis refert) Ptolaemeo quoque placuit, ut habetur in libro (a nobis tamen desiderato) quem de momentis scripsit. Praeterea alii quoque philosophi id ipsum sensisse videntur. Quod est quidem rationi consentaneum, supervolant enim, quae levia sunt, et si mente concipiatur eadem figura levis cuiuspiam esse, tunc si detineatur in G, partes undique aequalium momentorum consistent, essetque G (ut ita dicam) centrum levitatis."

[3] *Paraphrasis*, p. 17: "Ut itaque in planis quoque centrum gravitatis consideratur, ita etiam plana gravitate praedita considerare, non erit absurdum. Si enim impossibile esset considerare plana gravitate praedita, centrum quoque gravitatis in ipsis nullo modo concipi posset. Atque perspicuum est, centrum gravitatis in ipsis admitti ac designari posse, igitur et plana gravitate insignita. Et si mathematicus considerat corpora seclusa interim ipsorum gravitate et levitate: et astronomus corpora considerans caelestia, quae neque gravia neque levia sunt, non propterea considerat ea ex propria ipsorum natura, neque gravia neque levia esse; etenim quamvis gravia, vel levia essent, nihilominus neque gravia, neque levia esse ea consideraret. Quod si mathematicus hoc pacto huiusmodi corpora intelligere potest, quid prohibet rursum eadem, quamvis ut talia, neque gravita, neque levia sint, vel gravia, vel levia esse concipere?"

[4] *Paraphrasis*, p. 18: "In quibus omnibus de re admodum utili et ad quam plurima conducenti pertractat, quandoquidem ex iis, quae ab Archimede his libris docemur, in multarum rerum cognitionem pervenire possumus. Quod facile constat inprimis ipsiusmet Archimedis exemplo, siquidem hac methodo ipse in libro *De Quadratura Paraboles* comparando plana in libra constituta, ipsius paraboles quadraturam miro artificio adinvenit"

[5] *Paraphrasis*, p. 18: "ut affirmare non verear, nullum esse theorema nullumque problema

Archimedes's theory is in sharp contrast with Jordanus's and Tartagia's: they, too, would have tried to prove the law of the lever. But to none of their attempts would deserve the word "demonstration" since they would have based their reasoning on unnecessary and improbable argumentations.[1]
In contrast, who wants to learn the *true* principles of the science mechanics, has to approach Archimedes.[2]
After a short overview on the content, Guidobaldo turns to a final appeal:

> So it is clear that Archimedes really transmits the elements of mechanics, since he thoroughly treats two topics which represent, so to say, the foundations of this science: he proved namely the outstanding <law of the lever> already cited very frequently, and on the other hand the determined centres of gravities of planes. (...) Principally from Archimedes's writings, the access seems to be open to further, almost infinite mechanical theorems and problems. In fact, nothing can be shown in this branch, which does not draw on these treatises.
>
> And what is even more wonderful: the theorems of these books cannot only be used as foundation for other proves, but we can also thoroughly learn from these demonstrations the way itself of how to compose argumentations and proves, as we will show at its place. So, it can be concluded that nobody, by no means, can be considered to be a scholar of mechanics who is unacquainted with Archimedes's treatises. In fact, there cannot be science if the principles are ignored, as any learned man knows.[3]

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ad rem mechanicam pertinens, quod in sui speculatione peculiare non assumat fundamentum ex iis, quae Archimedes in his libris edisserit."

[1] *Paraphrasis*, pp. 18-19: "Et quamvis Iordanus Nemorarius (quem secutus est // Nicolaus Tartalea et alii) in libello de ponderibus hanc eandem propositionem quoque demonstrare conatus sit et ad eam ostendendam pluribus mediis fuerit usus, nulli tamen probationi demonstrationis nomen convenire potest. Cum vix ex probabilibus et iis, quae nullo modo necessitatem afferunt, et forasse neque ex probabilibus suas componat rationes. Cum in mathematicis demonstrationes requirantur exquisitissimae, ac propterea neque intermechanicos videtur mihi Iordanus ille esse recensendus."

[2] *Paraphrasis*, p. 19: "Quapropter ad Archimedem confugiendum est, si fundamenta mechanica, veraque huius scientiae principia perdiscere cupimus, qui (meo iudicio) ad hoc potissimum repsexit, ut elementa mechanica traderet, ut etiam Pappus in octavo *Mathematicarum Collectionum* libro sentit."

[3] *Paraphrasis*, p. 21: "Itaque perspicuum est, Archimedem proprie elementa mechanica tradere, quando//quidem duo pertractat, quae sunt tanquam elementa huius scientiae: fundamentum nempe illud praestantissimum iam toties praefatum, deinde centra gravitatis planorum ostendit. (...) Hisque <scriptis Archimedis> praesertim, ex quibus patet aditus ad ultra, ac paene infinita theoremata, problemataque mechanica. Nihil enim in hoc genere demonstrari potest, quod his non indigeat scriptis.
Et quod admirabilius est, nos non solum pro fundamento suscipere posse ad aliquod demonstrandum theoremata in his libris demonstrata, verum etiam ab his demonstrationibus perdiscere ipsum modum argumentandi et demonstrandi, ut suis loci ostendemus. Ita ut vere con-

V.2.3 The defence of the indifferent equilibrium

The defence of the indifferent equilibrium was one of the central purposes Guidobaldo had pursued by the edition of the *Paraphrasis*: the present subsection exposes arguments for our hypothesis that Guidobaldo used the *Paraphrasis* not only in order to furnish the first reliable version of Archimedes's *Equilibrium of Planes*. If this hypothesis is correct, Guidobaldo's mechanical work gains a coherency that is not confined only to the formal-logical aspect, but also regarding its approached topics.

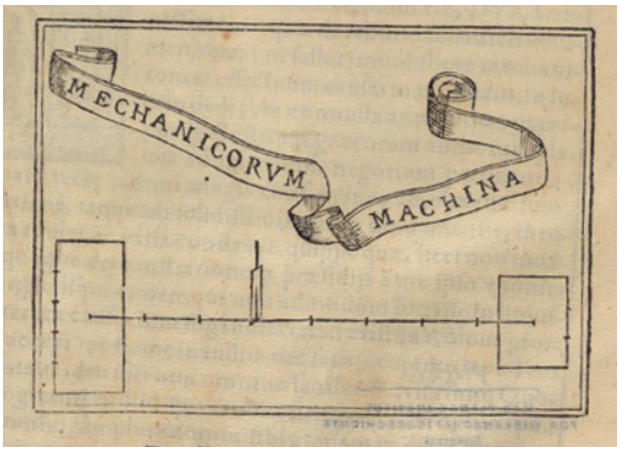

Figure V.7: The frontispiece of the *Paraphrasis*.

The first hint that Guidobaldo saw the *Paraphrasis* in a definite connection with his earlier work on the Simple Machines is contained already on the frontispiece: its figure shows a balance with weights inversely proportional to their distances from the fulcrum, overwritten by the label "*Mechanicorum Machina*" (cf. figure V.7). So, Guidobaldo considered the law of the lever as the foundation of the operation mode of the mechanical machines – in effect, he had reduce the Simple Machines to the lever in the *Mechanicorum Liber*. Now, in the *Paraphrasis* he commented and explained the *Equilibrium of Planes*, which demonstrated exactly this fundamental law.
The confirmation of this hint can be found as early as in the very first page of the book, in the dedicatory letter. There, Guidobaldo complains that

> Iam decemnium elapsum est, DVX Serenissime, es quo de rebus mechanicis volumen veras (ni fallor) mirabilium mechanicorum effectuum causas manifestans in lucem dedi; ubi (...) theoremata multa ac varia construxi (...). Plerisque tamen, qui non admodum fortasse in

cludendum sit, neminem prorsus inter mechanicos connumerandum fore, qui haec Archimedis scripta ignorat. Ignoratis enim principiis nulla est scientia, ut apud omnes sapientes perspicuum est."

> huiusmodi rerum causis investigandis versati existunt, nova prorsus (ut accepi) ac ferme inaudita (...) visa sunt.[1]

An analysis of his correspondence shows,[2] that these "unheard theorems" principally refer to his treatment of the isostatic balance which had predicted indifferent equilibrium,[3] in contrast to the mechanical elite of those times (Jordanus, Tartaglia, Cardano, Benedetti), who had exposed radically different solutions, not only concerning the result but also the approach and theory.[4]
After the critiques that he had received for his theory,[5] Guidobaldo had decided to have other authorities of mechanics plead his case, in order to defend him from the critics:

> Quocirca cogitanti mihi, qua ratione fieri posset, ut opus illud a me editum, quam plurimorum sibi gratiam in dies magis conciliaret, in mentem venit, non aliunde id mihi oportunius contingere potuisse, quam si priscos ipsos et gravissimos alioqui authores de hac re elegantissime disserentes illis offerrem. // (...) mihi constitui, ex multis unicum tantum <testimonium>, eumque reliquorum omnium hac in parte facile principem deligere: qui et meam causam tueretur et illis, si fieri posset, satisfaceret (...). Est autem gravissimus hic author Syracusius ille Archimedes de mechanicis elementis consultissime disserens.[6]

This citation explicitly testifies that Guidobaldo pursued not only the purpose of editing Archimedes's text, but to defend his *own* mechanical theory. In the following, we will see that this defence to his treatment of the isostatic balance. For this purpose, it is advisable to recall Guidobaldo's (direct) prove of the indifferent equilibrium on this kind of balance:[7]

[1] *Paraphrasis*, p. i (not numbered).

[2] Cf. Part B, chapter I, particularly I.3.

[3] There was another statement of the *Mechanicorum Liber* whose reception was accompanied by some scepticism: as we learn from a letter of Guidobaldo to Contarini letters (October 9th 1580; cf. Appendix II, I.8.3), some scholars did not succeed in reproducing the proportions between weights and forces that Guidobaldo had predicted for the pulleys. As the letter reveals, this was due to the fact that Guidobaldo's (right) theory was verifiable only with precision instruments, while Contarini apparently did not have at his disposal such instruments. Yet, the content of the *Paraphrasis* evidences that Guidobaldo with all probability did not refer to these theorems to be "unheard": he does not prove nor hint at anything that would be even distantly related to the topic of pulleys (or other Simple Machines, apart from the lever), whereas it is several times that he comes to speak about the indifferent equilibrium, as the present subsection will testify.

[4] For an overview on the different approaches to mechanics in the sixteenth century cf. Part A, chapter III; as far as the specific theories of the isostatic balance is concerned, cf. Part B, I.1.

[5] Again, cf. Part B, chapter I, particularly I.3.

[6] *Paraphrasis*, pp. i-ii (not numbered).

[7] For a detailed description of the respective part of the *Mechanicorum Liber*, cf. Part A,

This short, one-page demonstration consists of essentially three elements: Pappus's definition of the centre of gravity, according to which a body held in its barycentre stands still; the invariability of the position of a body's barycentre under translations and rotations (spoken modernly); and the Archimedean conception to consider balances as composed magnitudes, i.e. mechanical systems as autonomous physical entities with a definite, unique barycentre.
Guidobaldo's argumentation is the following: C is postulated to be the rotation point of the balance. Initially, the balance, with equal weights in A and B, is in the horizontal position: it is clear that the point C is also the barycentre of the whole system composed by the weights and the line connecting their centres of gravity. Now, if the balance is moved in the inclined position DE, there is no reason why the point C should not remain the barycentre. Consequently, for Pappus's *centre of gravity*-definition, the balance stays at rest in this inclined position which was to be proved.[1]

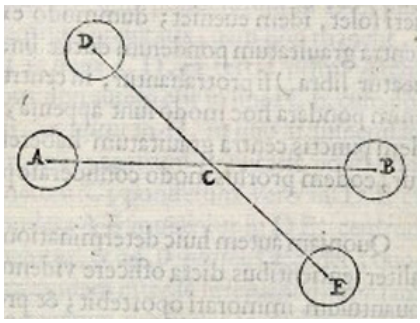

Figure V.8: The isostatic balance in Proposition IV of the *Mechanicorum Liber*.

So, a crucial role in this direct proof is played by the Pappian definition of centre of gravity. But this seems to have entailed a problem: the *Collectiones Mathematicae*, whose eighth book contains this definition, was not yet edited at that time:[2] so Guidobaldo referred to a text which was practically unavailable, apart from some few manuscript copies. This might have reduced his credibility. Further, the definition was not stated by Archimedes himself, so was it really to be accepted?

IV.2.2.

[1]The fact that the "balance-system" can be treated as new, autonomous physical entity, despite of its composition by *two* weights, implies an implicit use of the Archimedean concept of *composed magnitude*. This is crucial for Guidobaldo's solution, and completely different from other approaches, as of Jordanus or Benedetti.

[2]It would have been published only in 1588, in Commandino's translation, with Guidobaldo's help.

Exactly this problem of justifying his acceptance of the Pappian definition seems to have made Guidobaldo insert a lengthy digression in the preface of the *Paraphrasis* on the concept *barycentre* and its connection with the centre of the world. Interestingly, he thereby had recourse to the Aristotelian conception of the *cosmos*: the basic assumption is that a heavy[1] body is at rest in the centre of the world. Thus, respecting to the point that coincides with the centre of the world, all the parts must have equal moments. Otherwise, one part would preponderate compared to another and produce movement, in contradiction to the hypothesis of the body's rest in the centre of the world. And this point is, according to Commandino's definition, the centre of gravity. So, saying that a body *naturali propensione* moves to the centre of the world, means that the body wants to unify his centre of gravity with the centre of the earth.[2]
Since it is gravity that generates the natural propensity and the movement of a heavy body towards the centre of the world, and since, in effect, it is the centre of gravity of the body that really unifies with the centre of the world, every body can be said to weigh exactly and exclusively in its centre of gravity.[3]
Now, if then an arbitrary body is held in its centre of gravity, it has to stand still insomuch as the reason of its movement, namely gravity, does not act under these circumstances.[4] And *voilà* the statement of the Pappian barycentre-definition, derived by central elements of the Aristotelian cosmology. Guidobaldo could have been sure that this authority gave to the definition, so crucial in his theory of the isostatic balance, the necessary credibility.
Even before this digression, he had pointed out that a body held in its barycentre

[1] Heavy is the translation of "*gravis*", in the Aristotelian sense of the word.

[2] *Paraphrasis*, p.10: "Ex quibus colligi potest, si grave quidpiam in centro mundi collocatum fuerit, oportere centrum gravitatis illius in centro mundi constitutum esse: siquidem ut grave illud tunc quiescat, partes undique ipsum ambientes aequalium momentorum existere, atque manere oporteat. Quare, dum asseritur, grave quocumque naturali propensione sedem in mundi centro appetere, nil aliud significatur, quam quod eiusmodi grave proprium centrum gravitatis cum centro universi coaptare expetit, ut optime quiecere valeat."

[3] *Paraphrasis*, p.10: "Ex iis omnibus, quae hactenus de centro gravitatis dicta sunt, perspicuum est unumquodque grave in eius centro gravitatis proprie gravitare, veluti nomen ipsum centri gravitatis idipsum manifeste praeseferre videtur. Ita ut tota vis gravitasque ponderis in ipso gravitatis centro coacervata collectaque esse, ac tanquam in ipsum undique fluere videatur. Nam ob gravitatem pondus in centrum universi naturaliter pervenire cupit, centrum vero gravitatis (ex dictis) est id, quod proprie in centrum mundi tendit, in centro igitur gravitatis pondus proprie gravitat."

[4] *Paraphrasis*, p.10: "Praeterea quando aliquod pondus ab aliqua potentia in centro gravitatis sustinetur, tunc pondus statim manet, totaque ipsius ponderis gravitas sensu percipitur." This reasoning is valid, according to Guidobaldo, also when the body is held in a point whose connection to the centre of the world passes through the barycentre of the body. He explicitly refers here to the first proposition *De Libra* of the *Mechanicorum Liber*, as he did some lines before, justifying his supposition of the same work that heavy bodies move along their centres of gravity. These references to the *Mechanicorum Liber* in this digression are another clue that it was the justification of some of its contents that made Guidobaldo this passage to the preface of the *Paraphrasis*.

does not rotate: in the argumentation that refers to a general, three-dimensional body (the respective figure shows a prism), he underlines that the body "will stay in the position in which it was and no part of it rotates, and at all it does not change position."[1]
Then, at the end of the preface, Guidobaldo harshly criticised the main opponents of his theory of the isostatic balance, namely Jordanus and Tartaglia, whose theories (erroneously) predicted the return of the inclined isostatic balance to the horizontal. The very principles used by them would not be credible, and none of their attempts to prove the law of the lever would deserve the denomination as "demonstration". In contrast, one has to rely on Archimedes, in order to thoroughly learn the "foundations of mechanics and the *true* principles of this science".[2]

The next occasion to revisit the topic of the isostatic balance is the scholium to Archimedes's first axiom, few pages afterwards. Its statement, that equal weights equiponderate from equal distances, makes Guidobaldo reflect about the kind of balance referred to by the Syracusan mathematician. In effect, of two alternatives (cf. figure V.9) Guidobaldo favours the lower one, i.e. the isostatic balance: it would be testified by the Propositions IV and V of the *Equilibrium of Planes* that Archimedes considered this kind of balance -[3] unnecessary to say that this obviously emphasised the importance of Guidobaldo's own theory of the isostatic balance, exposed in the *Mechanicorum Liber*.
And another comment in this context clearly hints at the indifferent equilibrium on the isostatic balance:

[1] *Paraphrasis*, p. 9: "Ut si punctum A fuerit centrum gravitatis corporis BC, tunc ex Pappi sententia, si BC suspendatur ex A, magnitudo BC eadem, qua reperitur dipositione locata manebit, neque partes ullas ipsius corporis, ut quae sunt ad BC circumverti, neque omnino suum mutare situm depraehendetur."

[2] *Paraphrasis*, pp. 18-19: "Et quamvis Iordanus Nemorarius (equm secutus est Nicolaus Tartalea et alii) in libello de ponderibus hanc eandem propositionem quoque demonstrare conatus sit, ad eam ostendendam pluribus mediis fuerit usus, nulli tamen probationi demonstrationis nomen convenire potest; cum vix ex probabilibus et iis, quae nullo modo necessitatem affernt, et fortasse neque ex probabilibus suas componat rationes. Cum in mathematicis demonstrationes requirantur exquisitissimae, ac propterea neque inter mechanicos videtur mihi Iordanus ille esse recensendus. Quapropter ad Archimedem confugiendum est, si fundamenta mechanica, *veraque* huius scientiae principia perdiscere cupimus." The emphasis is ours.

[3] *Paraphrasis*, pp. 23-25 (the text refers to figure V.9): "Duobus modis gravia in distantiis collocata intelligi possunt, quod et in caeteris postulatis et in propositionibus intelligendum est. Etenim vel gravia sunt appensa, ut in prima figura aequalia gravia A, B sunt in C, D appensa, ita ut distantia EC sit distantiae ED aequalis; intelligaturque CD tanquam libra, quae suspendatur in E. Vel ut in secunda figura gravita A, B habend ipsorum centra gravitatis, quae sint C, D, inipsa DC linea, in pun//ctis nempe CD constituta; libraque similiter ex puncto E suspendatur, sitque distantia EC distantiae ED aequalis, erunt utique in utraque figura pondera A, B in distantiis aequalibus constituta. (...) Novisse tamen oportet, Archimedem in his libris potius intellexisse pondera esse in distanttis collocata, ut in secunda figura, quam appensa; ut es quarta et quinta // primi libri propositione patet. Demonstrationes enim clariores redduntur."

Moreover, it has to be noted that this postulate of Archimedes is true for weights arranged in any position: both if CED were horizontal, as well as if it were not, as in this first figure <(cf. figure V.10)>; and that it is always true in the same way, that equal weights C, D equiponderate from equal distances EC, ED, as will be clear below (namely after the fourth proposition of this book).[1]

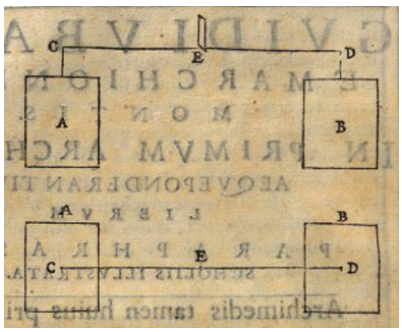

Figure V.9: According to Guidobaldo, Archimedes considers balances of the lower type in the *Equilibrium of Planes*: i.e. the isostatic balance.

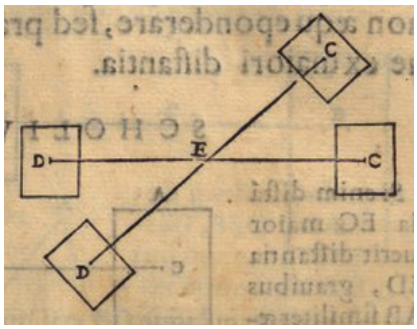

Figure V.10: The statement of "equal weights in equal distances equiponderate" refers both to horizontal and to inclined balances, according to Guidobaldo.

So, what contained the comment on this fourth proposition? In effect, it is one of the crucial passages in regard. The theorem states that if two equal magnitudes do not have the same centre of gravity, the centre of gravity of the magnitude composed by those is situated in the midpoint of the line connecting the barycentres of the two (initial) magnitudes. Its demonstration contains two elements about the concept *centre of gravity* that can be found only in this place and nowhere else in Archimedes's writings: namely, firstly, the barycentre of two connected magnitudes lies on the line through their centres of gravities; secondly, the claim, that a body held in its centre of gravity equiponderates, sheds some light on the (rather obscure) conceptual relation between the two Archimedean key notions *centre of gravity* and *equiponderation*.
The fact of their obscure logical interrelation was one of the reasons why Guidobaldo's theory of the isostatic balance was not accepted.[2] So he used the occasion of this

[1] *Paraphrasis*, p. 25: "Porro non ignorandum hoc Archimedis postulatum verificari de ponderibus quocunque situ dispositis, sive CED fuerit horizonti aequidistans, sive minus, ut in hac prima figura; eodem modo semper verum esse pondera aequalia C, D ex aequalibus distantiis EC, ED aequeponderare, ut infra (post scilicet quartam huius propositionem) perspicuum erit."

[2] Further, Proposition IV offered one of the elements to reconstruct Archimedes's Theory of Equilibrium: also this is stressed by Guidobaldo in the scholium after the fourth proposition.

proposition to insert a scholium of more than seven pages, dwelling essentially on five topics, emphasising their significance for (obviously Archimedean) mechanics in general:

> With extreme diligence, we have to consider several elements which Archimedes uses in this proposition, since they are common and highly useful in this science.[1]

The first point is why the balance with two weights can legitimately be considered as a unique body, an autonomous physical identity: this is both a central element of the Archimedean mechanics,[2] as well as one of the three elements of Guidobaldo's prove of the indifferent equilibrium on the isostatic balance, as we have seen above. In effect, he explains: admittedly, at the beginning "the two magnitudes A, B are separated and different",[3] but

> thanks to the line AB they are made to one single magnitude. The function <of the line> is not only to connect the magnitudes A, B so that they cannot neither get closer or farer away each to each (...). But also, if it is hung up from C, it has to be understood that the line AB lies in straightness, and that it moreover sustains the magnitudes A, B. And quadrilaterals, pentagons, cubes or something similar do not constitute in a greater measure one single magnitude than it does the magnitude composed by A, B together with the line AB. So if it is just one single magnitude, it has one single barycentre.[4]

So it is the invariability of the reciprocal positions of the weights, as well as the possibility to be sustained (and equilibrated) in a certain point, that makes the two, initially separated weights a single, autonomous, composed magnitude.

The second point underlined by Guidobaldo in the scholium refers to the relation between *centre of gravity* and *equiponderate*:[5] the demonstration of the

On this topic, cf. Part B, chapter II.

[1] *Paraphrasis*, p. 43: "Summopere autem animadvertenda sunt nonnulla, quibus utitur Archimedes in hac propositione, cum sint communissima et maxime utilia in hac scientia."

[2] In effect, the peculiarity of this interpretation becomes clear if it is compared to the other approaches to mechanics, as the one of Jordanus: he did not consider the balance as a unique physical body, but regards the two weights on it *separately*: in effect, he compares *two*, hypothetical descents of the weights.

[3] *Paraphrasis*, p. 43: "Nam magnitudines A, B sunt invicem separatae et sunt duae (...)."

[4] *Paraphrasis*, p. 43: "efficitur $<AB>$ una magnitudo a linea AB; cuius munus est non solum connectere magnitudines A, B, ita ut neque ad se amplius accedere, neque recedere invicem possint (...). Verum etiam si suspendantur ex C, intelligendum est linea AB in rectitudinem iacere, insuperque sustinere magnitudines A, B. Neque magis una est magnitudo quadrilaterum, pentagonum, cubus et huiusmodi aliae, quam sit magnitudo quae componitur ex magnitudinibus A, B una cum linea AB; quod si est una tantum magnitudo, ergo unum habet centrum gravitatis."

[5] He emphasised its relevance by the phrase (cf. *Paraphrasis*, p. 44): "Argumentandi modus inest in hac demonstratione maxima consideratione dignus, et huius scientiae maxime proprius."

fourth proposition states that a body/magnitude, held in its centre of gravity, equiponderates. So, Guidobaldo explains, "if the magnitude composed by A, B is suspended from <its centre of gravity>, it stands sill in its position, and does not incline to any side".[1] Also this comment obviously has consequences for the isostatic balance.

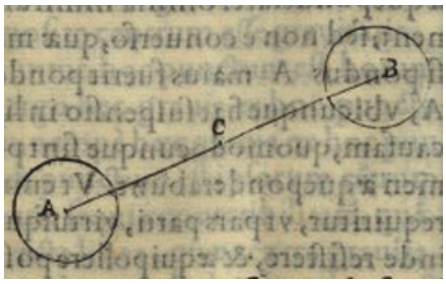

Figure V.11: Another reference to the isostatic balance and its indifferent equilibrium on page 46 of the *Paraphrasis*.

As third aspect approached is a closer description of the concept *equiponderation*. This is a most remarkable passage,[2] but is not immediately connected with our present purpose. Anyway, Guidobaldo concludes this passage with another *explicit* textual and graphical (cf. figure V.11) reference to the indifferent equilibrium:

> *Paraphrasis*, pp. 46/47: "Ut si linea AB fuerit, sive non fuerit horizonti aequidistans, ipsius medium C centrum erit gravitatis magnitudinis ex magnitudinibus A, B aequalibus compositae. Unde sequitur, si appendantur pondera A, B ex C, aequeponderare (...). Ex quibus sequitur lineam AB ponderaque manere eo modo, quo reperiuntur, ut in nostro *Mechanicorum Libro* in eodem tractatu *De Libra* demonstravimus et adversus illos, qui aliter sentiunt, abunde satis disputavimus."

Even the scholium which prepares the sixth proposition contains an implicit reference to the inclined isostatic balance: Guidobaldo explains that a weight on a balance can be replaced by another system of weights as long as the system, in all, weighs as much as the initial weight, and the barycentre of the system is

So, it is to this passage, and to the scholium before the sixth proposition, to which Guidobaldo refers in the preface that "from these demonstrations <of the *Equilibrium of Planes*> we thoroughly learn the way itself to argue and to demonstrate <in mechanics>, as we will show at its place." (cf. *Paraphrasis*, p.21: "ab his demonstrationibus perdiscere ipsum modum argumentandi et demonstrandi, ut sui locis ostendemus.")

[1] *Paraphrasis*, p. 44: "si magnitudo ex A, B composita suspendatur ex D, manebit ut reperitur, nec amplius in alteram partem inclinabit."

[2] In effect, its analysis is exposed in Part B, II.4.2.

located where the weight's was before – this is the crucial idea of Proposition VI. So the weight in E can be substituted by the system of the weights in C and D (cf. figure V.12), without modifying the mechanical situation.

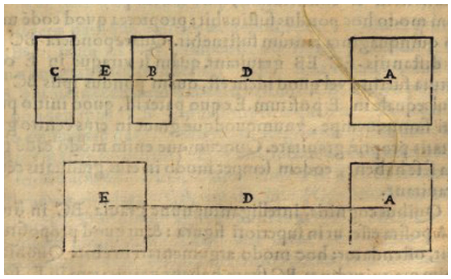

Figure V.12: These two mechanical systems are equivalent, as long as the gravity of the weight in E and of the system of weights B, C is the same and their barycentres coincide in E, according to the Archimedean theory.

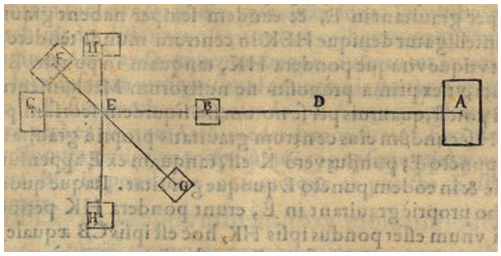

Figure V.13: The substitution of weights can be realised in many ways: the weight in E could be replaced even by a (possibly inclined) isostatic balance with same gravity and barycentre-position.

But many other substitutions would be admissible in this regard: the fundamental condition is the equal gravity of both systems and that the position of the barycentres of both systems remains the same. In that case, the weight in E can be replaced also by an isostatic balance with rotation point and barycentre in E, and equal comprehensive gravity (cf. figure V.13). If it is inclined, the position of the centre of gravity (namely E) remains unvaried.[1] And *voilà* the third (and last) element of the direct proof of the indifferent equilibrium, revisited and reconfirmed by Guidobaldo in the *Paraphrasis*.

The elements exposed in the present subsection are sufficient, we believe, to prove that Guidobaldo used the *Paraphrasis* to revisit the topic of the indifferent equilibrium on the isostatic balance and to defend it "against those, who have a different opinion". Moreover, he interprets the *Equilibrium of Plane* in the light of his own discovery, claiming that the kind of balance there referred to is the isostatic one.

This fact entails two consequences: firstly, by the revealing of this connection between the *Paraphrasis* and the *Mechanicorum Liber*, Guidobaldo's mechanical

[1] *Paraphrasis*, p. 57: "Iisdem namque positis aequeponderarent scilicet gravia ABC facta ex D suspensione. Sitque punctum E centrum gravitatis ponderum C, B, quae quidem pondera C, B gravitatis centrum habeant in linea CB. Dico pondus A ponderis ipsis C, B simul sumptis aequali in E constituto aequeponderare. Mente concipiamus distantia EC, EB, manente centro E, circa ipsum circumverti posse, ut modo sint in FEG, modo in HEK. Similiter intelligantur pondera CB modo in FG, modo in HK existere. Quoniam igitur punctum E centrum est gravitatis ponderum C, B, erit idem E (cum situm non mutet) centrum gravitatis ponderum in situ FG, ac ponderum in HK existentium."

work gains a coherency which, so far, it did not seem to have had. Secondly, this *modus operandi* of interpreting the Archimedean work in the light of his own (original) mechanical theory is relevant to understand an important part of Guidobaldo's scientific personality, in our opinion: his examination and restoration of Archimedes's work was no mechanical, automatic and sterile rumination or "chewing over": he built an interesting synthesis between his *own* theory and Archimedean elements.[1]

V.2.4 Mechanics and natural philosophy

In the preface, Guidobaldo exposes some interesting conceptions about the relation between mechanics and natural philosophy, which offers us a rare insight of his understanding of mechanics.

First of all, his idea of the equal status of Archimedes and Aristotle for the field of mechanics might appear somewhat surprising: Guidobaldo's mechanical work shows a profound occupation with and examination of the central concepts and methods of Archimedes, while his references to the Aristotelian mechanics seem to be limited to some scattered citations of the *Quaestiones Mechanicae*. Yet, the idea that mathematics was *not* sufficient to describe mechanics can be already found in the *Mechanicorum Liber*. In fact, there he states

> Thus there are found some keen mathematicians of our time who assert that mechanics can be considered either only mathematically, or physically; as if mechanics could sometimes be regarded either without geometrical demonstrations or withouth the true motion.[2]

In the preface of the *Paraphrasis*, this conception of mechanics' composition by two components is accentuated and developed notably father: a "natural" one, as mechanics refers to phenomena set in nature ("*naturalia*"), and other hand a mathematical one, as it has recourse to mathematical notions like *distance* or *proportion*. Both domains now are represented by its major exponents, Aristotle as authority of natural philosophy and Archimedes as the most excellent mathematician.
Interestingly, although Guidobaldo undoubtedly was a follower of the Archimedean approach to mechanics, he did not consider Aristotle's treatment of the mechanical foundations as inferior:

[1] The following subsection V.2.4 will present a similar proceeding of Guidobaldo: so, his interpretation of the Archimedean mechanics according to his own theory of indifferent equilibrium was no isolated case.

[2] *Mechanicorum Liber*, p. viii (not numbered): "Reperiuntur enim aliqui nostraque aetate emunctae naris mathematici, qui mechanicam tum mathematice seorsum, tum phisice considerari posse affirmant; ac si aliquando vel sine demonstrationibus geometricis, vel sine vero motu res mechanicae considerari possint."

> In fact, at the beginning of the *Quaestiones Mechanicae*, Aristotle has laid bare many and extraordinary elements for discerning the *causes* of mechanical phenomena. In his writings, Archimedes has followed him and brought to light the principles of mechanics more clearly, making them even more intelligible. But Aristotle does no turn out to be belittled for this reason: in fact, he excellently explained the *causes* of those problems he had presented and treated. (...) for example, Aristotle asks why we move heavy weights with a lever. And he replies that the *cause* is the larger length of the law on the side of the force: and he certainly is right.[1]

This passage might shed some light on Guidobaldo's surprising valuation: it seems that he interpreted Aristotle's treatment as explanation of the *causes*[2] of the mechanical phenomena – correspondingly to the "task" of philosophy: the search of the causes. Archimedes, on the contrary, dealt with the mathematical description of the phenomena, and reached in this regard a more accurate determination.
But Guidobaldo's conception of the relation between Archimedes and Aristotle goes beyond attributing them an equal and equipollent status: he presents a kind of concordism, claiming that Archimedes followed in his axioms what Aristotle had shown and that the agree also in their conception of mechanics as subdivided in the two domains.

Another highly interesting argumentation in regard is the explanation of the properties of the barycentre in the preface,[3] which can plausibly interpreted as justification of the Pappian *centre of gravity*-definition. In this reasoning, Guidobaldo had recourse to the Aristotelian conception of the cosmos, according to which there are *natural places*, *heavy bodies* that tend to the centre of the world, with gravity as *cause* of this movement.
Now, as subsection V.2.3 has revealed, this passage had a precise function in the defence of Guidobaldo's own theory of the isostatic balance. However, beyond this, the passage is of crucial importance for the whole Archimedean mechanics, as the notion of *centre of gravity* is its basic concept, whose definition, though had not come down in the extant Archimedean writings. Maybe it was the belief, that also Archimedes agreed with the bipartition of mechanics, why Guidobaldo

[1] *Paraphrasis*, p. 4: "Aristoteles enim in principio *Quaesionum Mechanicarum* multa, eaque praecipua ad *causas* rei mechanicae dignoscendas aperuit. Quem secutus Archimedes in his libris mechanica principia explicatius patefecit eaque planiora reddidit. Nec propterea Aristoteles diminutus exstitit: etenim eorum quae ab ipso proposita et explicata fuere, problematum *causas* egregie patefecit. (...) Aristoteles enim (gratia exempli) quaerens cur vecte magna movemus pondera. *Causam* esse ait longitudinem vectis maiorem ad partem potentiae: et recte quidem." The emphases are ours.

[2] Note the triple recurrence of the word "*causa*" in this short passage.

[3] A summary of this reasoning is exposed in Part A,V.2.3, p. 203.

approached the explanation of the concept in in cosmological-philosophical terms: in fact, some pages before, he had claimed that

> In fact, the aspects that have to be considered mathematically, have been proved by Archimedes using geometry: like distances, proportions and so on. In contrast, what is related to nature ("*naturalia*"), has been treated by him according to nature ("*naturaliter*"): like the argumentations which concern the centre of gravity, or the objects that have to move upwards or downwards, and so on.[1]

The cosmological barycentre-reasoning had much more far-reaching implications as for only the *centre of gravity*: as this is the basic notion of Archimedes's theory, its correlation and dependency of the general conception of the cosmos and of natural philosophy meant above all: the integration of Archimedes's mechanics as part of the Aristotelian cosmos.
It was in this way, that Guidobaldo put into effect his conception that mechanics was constituted by two domains, one relative to mathematics and the other to natural philosophy: the ontological justification of the properties of *centre of gravity*, used in Archimedes's treatise, with recourse to cosmological-philosophical argumentations made his theory, described by geometrical means, a part of natural philosophy.
Here, again, it is advisable to underline an aspect we have already encountered in V.2.3: in Archimedes's writings there is no trace of such a connection of mechanics to natural philosophy. Once again, Guidobaldo interpreted the Archimedean theory according to his *own* conceptions and consequently use it, to some extent, for his own purposes. So, as much as Guidobaldo's approach to Archimedean mechanics can be characterised as philological, it has to be admitted that the interpretation Guidobaldo gave to it changed its meaning.

Another telling topic in regard is Guidobaldo's occupation with *light bodies* (in the Aristotelian sense) in the preface. Evidently without any real application to mechanics, it symbolises maybe at the best Guidobaldo's reflections on philosophical concepts in connection with mechanics.
Now, the problem was the following: the topic of Archimedes's treatise were *plane figures*, i.e. not only objects without gravity, but mathematical abstractions. Yet, as the precedent passages have evidenced, Guidobaldo could not agree with a conception of mechanics that confined itself to the consideration of geometrical problems. So, these objects and their relation to reality constituted a

[1] *Paraphrasis*, pp. 4/5: "Nam quae mathematice sunt consideranda, geometrice <Archimedes> demonstravit, ut sunt distantiae, proportiones et alia huiusmodi. Quae vero sunt naturalia, naturaliter quoque consideravit; ut ea, quae ad gravitatis centrum spectant, et quae sursum et quae deorsum moveri debent et cetera huius modi."

serious problem for Guidobaldo's conception of mechanics, as it had to refer to objects with a precise meaning in natural philosophy.
He found an ingenious solution for this dilemma: Archimedes's treatment would not closely be connected with *heavy bodies*. And also Aristotle and Ptolemy would have had the same conception, attributing *moments* both to *heavy* and to *light bodies*. So, the Archimedean treatment would hold also for *light bodies* to which, analogously as for the *heavy bodies* the centre of *gravity*, could be assigned a centre of *lightness*. Correspondingly, light bodies held in their centre of lightness would stand still – and the geometrical treatment of the centre of lightness would be analogous to the centres of gravity.
But also if one did not want to consider planes, for their lack of gravity, *light bodies*, this would not change anything: in effect, also astronomy would deal with objects, i.e. the planets and the stars, that due to their collocation in the superlunary world, would not be neither *heavy* nor *light*.

Chapter VI

The *Meditatiunculae*[1]

The Meditatiunculae *constitute an extremely interesting manuscript: on the one hand, they permit an insight into the genesis of some of Guidobaldo's works, like the* Perspectivae Libri sex, *the* Cochlea *or his lost treatises on gnomonics and on the movement of Earth; on the other hand, the manuscript contains itself interesting results and hints at certain approached problems (regarding the hydrostatic balance, practical questions, the movement of bodies in fluids etc.) of which the* Meditatiunculae *represent the only existing testimony. Of particular interest are the last pages which seem closely connected to the author's collaboration with Galileo.*[2] *Further, more generally, the manuscript is a most precious document of Guidobaldo's scientific* modus operandi.
Even if the entries regarding mechanics constitute only a little part of the Meditatiunculae, *they offer an insight of notable importance into Guidobaldo's mechanical work which can be considered to be similarly important as his printed works for a better comprehension of his mechanics.*

VI.1 Contextualisation

Besides the general difficulties to contextualise a writing whose dating is unclear, there surely are two aspects of Guidobaldo's life and work whose consideration seems to be relevant for studies on the *Meditatinculae*: firstly, he was an extremely versatile mathematician with interests extending to a wide range of mathematical branches, cf. VI.1.1; secondly, his close connections particularly to the Urbinate

[1] "*Meditatiunculae*" is the title of the manuscript *Latin 10246* of the Bibliotèque National de France at Paris. It has been completely transcribed by R. Tassora. This transcription and the analysis of several aspects of the work are contained in R. Tassora, *Le Meditatiunculae de rebus mathematicis di Guidobaldo del Monte*, Tesi di Dottorato 2001, Università di Pisa. The citations of the present chapter mainly follow Tassora's transcriptions. An html-version of the transcription can be found at http://echo.mpiwg-berlin.mpg.de/content/mpiwglib/pesaro.

[2] A detailed study of these last pages and their collaboration in general would be a *desideratum.*

court, as well as his function as Count of Monte Baroccio, appear to have had notable influences of different kinds on his scientific work: traces of this can be found especially in the *Meditatiunculae*, cf. VI.1.2.

As far as the problem of dating the manuscript is concerned, it does not contain any explicit chronological references, with one exception: there is a folio with data of astronomical observations, which is, however, loose, therefore it is unsuitable to clear the drafting period of the *Meditatiunculae*, both absolutely and relatively. In fact, the determination of their drafting period is one of the major problems connected with the manuscript. This question obviously is crucial for any possible conclusions concerning the topics on which Guidobaldo was working in a certain period. Further, a solution of the dating seems to be even more urgent if the connections of a part of this manuscript with the scientific work of Galileo are taken into account. The standard dating of the manuscript allocates its composition in the period between ca. 1586 and 1593: there is no doubt that a consistent part of the writing actually stems from this period. As an analysis of its mechanical content reveals, however, doubts about this dating – if referred to the *whole* manuscript – do not seem unfounded (cf. section VI.2). It seems possible that its first part goes back to an earlier phase of Guidobaldo's scientific activity.
Anyway, there are some hints that permit an at least approximative answer to the problem of dating the manuscript: first of all, as R. Tassora has proved,[1] the order of the pages in the *Meditatiunculae* reflects, in substance, the chronological order of their composition: their numbering stems from Guidobaldo himself, and there are not less than 26 cross references to successive or precedent pages.[2] This excludes the fact that the manuscript was compiled or modified after Guidobaldo's death. Therefore, several entries that refer to antecedent pages prove that the topographical order corresponds – in substance – with the chronological one. Moreover, citations of other mathematical works in the text permit to find *termini post quem* for certain pages. Of particular importance is, in this regard, the citation of Francesco Barozzi's *Admirandum illud geometricum problema tredicim modis demonstratum* (1586) on pages 149-151.[3] Together with the founded hypothesis of the chronological order of the pages, this constitutes a *terminus post quem* for the entries successive to page 149. Other citations, in contrast, do not seem significant in regard, as for example the reference on page 31 to the Italian translation of Alessandro Piccolomini's paraphrase of the *Quaestiones Mechanicae*, published in 1582 by Oreste Biringucci: the respective

[1] Cf. R. Tassora, *Le Meditatiunculae de rebus mathematicis di Guidobaldo del Monte*, cit.

[2] For example, page 19 refers to page 129, 34 to 62, 112 to 45/46, 120 to 233, 185 to 129 etc. Note that many of the cross references are contained in the text body, not in marginal or interline-additions. Cf. R. Tassora, *Le Meditatiunculae de rebus mathematicis di Guidobaldo del Monte*, cit.

[3] Cf. R. Tassora, *Le Meditatiunculae de rebus mathematicis di Guidobaldo del Monte*, cit.

paragraph is separated and written in different ink as the main body of page 31; therefore, it can plausibly considered as a later comment which is not useful for dating the primal drafting of the entry.[1]
In-depth studies of the dating problem would be a *desideratum*, particularly against the background of the relevance that this question assumes for all consecutive conclusions basing on it: in fact, important implications for Guidobaldo's work, depending on this dating are *inter alia*: the starting point of his studies on the *Cochlea*, on the *Problematum astronomicorum Libri septem*, on the treatise *De Motu Terrae*, his works on gnomonics, his studies of the inclined-plane-problem and many more.

Another remarkable fact, hinting at Guidobaldo's close collaboration with his scientific environment,[2] is that the inserted folios 115^1115^7 (*recto* and *verso*) contain entries of Guidobaldo's hand mixed with a different one. A palaeographical analysis reveals that the author could have been Pier Matteo Giordani, i.e. Guidobaldo's closest scientific interlocutor and friend.[3]

VI.1.1 Guidobaldo's mathematical versatility

The previous sections, dedicated to the contextualisation of the *Mechanicorum Liber* and *Paraphrasis*, have revealed and documented Guidobaldo's activity as architect, as teacher of future engineers in the Duchy of Urbino, his interest in philosophy and the existence of a scientific-technical environment around him. After the consideration of these framework conditions, it is time to deal more closely with his actual occupation with mathematics, which was doubtlessly influenced to a notable extent by the aforesaid circumstances.
An important aspect of Guidobaldo's work in general is his notable mathematical versatility, his interests reaching from pure geometry over gnomonics, music, astronomy, optics to perspective and mechanics (including problems regarding natural philosophy, according to those times' classification). This fact – already

[1] Further, we do not completely agree with Tassora's conclusions regarding Pappus's *Collectiones Mathematicae*: as the studies on Guidobaldo's biography and environment in the context of the present doctoral thesis have revealed, his knowledge of large parts of the Pappian work dates back to the early 1570s, and not to the period around 1587/88 when he worked on the publication of Commandino's translation.

[2] For further information on this topic, cf. Part A, chapter II, as well as sections IV.1 and V.1.

[3] In this occasion, we would like to thank prof.s P. d'Alessandro and A. Tontini for their help in this palaeographical analysis. In this context, it is interesting to note that also the manuscript *De Proportione composita* is partly written by Giordani: in fact, the first one and a half pages of the introduction are written by Giordani, before his hand is replaced, in the middle of a phrase, by a different one; the collocation of the manuscript is BOP, ms 631. It has been published in E. Giusti, *Euclides reformatus. La teoria della proporzioni nella scuola galileana*, Torino, Bollati Boringhieri, 1993.

suggested by the subjects approached in this printed treatises dealing with mechanics, perspective and astronomy – is reflected best by the *Meditatiunculae*: in an almost continuous alternation of topics, ample space is dedicated to perspective (ca. 70 pages), pure geometry (ca. 60 pp.), astronomy (ca. 40 pp.), mechanics (ca. 30 pp.), gnomonics (ca. 30 pp.), practical problems (ca. 10 pp.), optics (5 pp.), natural philosophy (5 pp.), and music (1 page).

A salient element of the *Meditatiunculae* is the fact that the single topics generally are not embedded in coherent thematic blocks,[1] but alternate with often completely unconnected subjects, frequently concerning even different mathematical branches. It does not seem, however, that this lack of organic systematisation, can be attributed to a scarce grade of elaboration, possibly due to the fact that the *Meditatiunculae* represented a notebook of scientific ideas of whims: on the contrary, the material exposed in the manuscript – apart from few exceptions particularly concerning the final pages on perspective – is presented in a very tidy and organised form, with numerous entries without any correction, modification or later addition. This suggests that the (large portion of the) material in the *Meditatiunculae* do already constitute alaborated versions of antecedent, generally lost drafts.[2] This hypothesis seems to be confirmed by other manuscript material of Guidobaldo, constituting the manuscript UCLA, ms 170/624: it consists of loose folios whose state generally appears more tentative, sometimes even crude, compared to the majority of the *Meditatiunculae*-entries, with a conspicuous number of interventions.
So, the missing coherence and systematisation of the topics approached in the notebook seems to be related with other factors: one element seems to be Guidobaldo's very versatility with could entail the risk to get distracted from dealing certain topics or branches more systematically.[3] Another relevant aspect in regard were the distractions, caused by external factors like his close connection to the Urbinate court (cf. VI.1.2) or his activities like architect-engineer, which hindered him in developing a coherent scientific formulation of certain mathematical branches.
So, all in all, the *Meditatiunculae* seem to be a precious source also for Guidobaldo's *modus operandi* in mathematical researches.

[1] An exception is constituted by the pages regarding astronomy (pp. 79-111) and perspective (pp. 155-205) which cannot distract, however, from the general impression of the missing coherence between the single topics approached in the rest of the manuscript.

[2] In some cases, these initial drafts are still conserved: the pages 37bis and 146bis are folios stuck in at a later time and seem to reflect the original status of Guidobaldo's considerations, with many interventions, entire lines and paragraphs added or cancelled. Other examples are contained in UCLA, ms 170/624, cf. P. Neville, *The Printer's Copy of Commandino's Translation of Archimedes, 1558*, in "Nuncius", VI 2 (1986), pp. 7-12.

[3] In fact, considering his mechanical work, certain elements are characterised by incoherency, others seem to be not completely developed, cf. Part A, IV.2.3 and Part B, II.4.5; about his incomplete treatment of the concept *moment*, cf. Part B, chapter II.

Another characteristic of the *Meditatiunculae* is his prevalent occupation with *applied* mathematical branches, as perspective, astronomy or mechanics: only a small part is dedicated to pure geometry. This seems, in effect, to reflect Guidobaldo's general interests.
Yet, he constantly had recourse to a mathematical technique which permitted him to approach all the aforesaid branches, namely was the Euclidean Theory of Proportions. His notable mastery of this instrument is testified in the *Meditatiunculae* (e.g. in the pages on perspective), but also in his mechanical writings: so, one of the major problems approaching the comment on the *Equilibrium of Planes* in the *Paraphrasis* was the restoration of the mathematical integrity of the text which had been damaged in the course of its transmission and presented a lot of problems:[1] several propositions contained non-demonstrated steps (prop. 4, 6, 13) or even were inconclusive (prop. 7). Guidobaldo, however, succeeded in including the missing steps and in restoring the logical integrity of the text by having recourse to the prove techniques of the Theory of Proportions.
Moreover, besides his overall orientation to applied mathematical branches, he dedicated parts of his scientific work to the reflection on these theoretical basis: in two still extant manuscripts,[2] he attended to crucial topics of the Euclidean *Elements*: he wrote a comment on Book V, i.e. exactly the part where the Theory of Proportions is exposed, as well as an *opusculum* on the composed proportion, a conceptual instrument that permitted to deal with composed magnitudes: it served especially for establishing mathematical models of physical magnitudes or phenomena, like *moment*, *specific weight* or various kinds of motion.[3]
Guidobaldo's works are dedicated to the elucidation and discussion of the most nebulous or difficult passages, sometimes going beyond Commandino's comment of the *Elements* (1572). His intent was to furnish an interpretation of the Theory of Proportions, at the same time plausible from a mathematical standpoint and correct from a philological one.[4]

Finally, Guidobaldo's occupation with music merits some reflections: does the page in the *Meditatiunculae*, belonging to the part apparently connected with Galileo, constitute an isolated case, or was it part of a wider activity?
The studies on his biography and scientific environment seem to confirm the second alternative: in fact, one of Guidobaldo's friends and interlocutors, Ludovico

[1]For further information about the *Paraphrasis*, cf. Part A, chapter V.

[2]The manuscripts are conserved at the Biblioteca Oliveriana, entitled *In quintum Euclidis Elementorum Librum Commentarius* and *De Proportione composita Opusculum*, with respective collocations BOP, mss 630 and 631.

[3]For further information on this topic, cf. E. Giusti, *Euclides reformatus. La teoria della proporzioni nella scuola galileana*, Torino, Bollati Boringhieri, 1993.

[4]Cf. in regard E. Giusti, *Euclides reformatus*, cit., pp. 13-22; and P.D. Napolitani, *Sull'Opuscolo* De Proportione composita *di Guidobaldo dal Monte*, Pisa, Università di Pisa, 1982.

Agostini, calls him "friend and scholar of music, not to a minor extent than of mathematics".[1] An important confirmation of this claim, whose reliability was unclear up to now, is contained in the correspondence of two of Guidobaldo's interlocutors, Almerico and Virginio Almerici: as a a recently found letter between them reveals, Guidobaldo was the composer of *moresche*, a 15th/16th-century dance and song genre.[2] So, these two independent sources testify Guidobaldo's practical and theoretical interest in music. The page in his manuscript notebook hence seems to be embedded in a larger context of studies on music, for which the *Meditatinculae* constitute, for now, the only testimony. This trait of the Marchigian mathematician constitutes another element which might explain his excellent relations with Galileo: it must have been a further interest in common.

VI.1.2 Guidobaldo's role as courtier

A fundamental aspect of Guidobaldo's biography has not yet been considered in a detailed way, namely his role as courtier and, more generally, his occupation with political-administrative tasks, particularly as Count of Monte Baroccio and as head of his family. It is worth to dwell a bit on this dimension of his activity, for it occupied consistent parts of his time and conditioned even his scientific work in a remarkable way. Since large parts of the *Meditatiunculae* are drafted in the period between 1586 and 1593, their creation is related to these circumstances: it coincides with Guidobaldo's first years as Count of Monte Baroccio as well as head of his family, and comprises a time for which several sources document various tasks he was commissioned by the Duke.
Further, his close connection to the Urbinate court seems to be a relevant distinguishing mark in comparison to other sixteenth-century scholars of mathematics and mechanics like Maurolico or the young Galileo. On the one hand, this *milieu* offered stimuli and prepared certain general, cultural attitudes that seem to have influenced Guidobaldo's work;[3] on the other, the duties connected with his high position distracted him from his actual scientific activity. Besides, also his autonomy in his studies appears to have been influenced by requests of the Duke.[4]

[1] This citation is concerned in Agostini's work *Giornate Soriane*, a description of the courtly life at Pesaro; cf. L. Agostini, *Le Giornate Soriane*, cit.: "e non ci parendo tempo né occasione da por mano agli strumenti da suono, così come propose il Signor Guidobaldo, non men amico e scienziato di musica che di matematica si sia, si cantarono alcuni motetti di Adriano e, quando ci parve tempo da riposar le voci, demmo mano alle loro reti da pescare che tratte si chiamano; (...)." See Appendix I, I.2.3, for the transcription of the relevant passage.

[2] Cf. Appendix I, I.2.3

[3] Cf. Part A, chapter II and sections IV.1, V.1.

[4] In fact, certain elements of Guidobaldo's and Commandino's work might possibly find an explication in their close relations to the court-*milieu* – Commandino, besides his connections to the Urbinate court, was priorly active in Vatican circles and at the Farnese court at Parma: among these aspects might be counted their common characteristic of a pronounced didactic

What was Guidobaldo's role at court? This question is not easily answered at the current state of the art. Important documents in this regard, however, have been recently found, namely the lists of the "*famiglia*" of the years 1586-89,[1] which register the members of the court with the respective "*spesa*" and "*provisione*":[2] Considering these kinds of "payrolls" which seem to reflect the hierarchy of the court,[3] it emerges that all the listed courtiers had precise tasks.[4] Guidobaldo is listed after Ranieri dal Monte, and (even) before the Duke's intimate Giulio Cesare Mamiani. What were his tasks? Given the distribution of the duties (exemplified in footnote 4), it is improbable that Guidobaldo was included because of a general, abstract recognition of the services of his family towards the Dukes of Urbino. With all probability, his high position (and provision) was connected with a precise function in the political-administrative apparatus of state. As far as can deduced from the present documentation of Guidobaldo's life, he did not ever fulfil diplomatic missions, nor did he assume administrative functions; in contrast, several sources testify his activity regarding scientific-technical questions: the composition of mathematical treatises (in occasion of the calender reform, Pappus's *Collectiones Mathematicae*, the treatise on sundials in 1587), on-site inspections of ducal construction projects (the works at Villa Miralfiore, at the fountain in front of the ducal palace in Pesaro, hints at works concerning the port and regarding military architecture) as well as the supervision of the clock fabrication were important elements both of Guidobaldo's work as well as for the functioning of the apparatus of the ducal state.[6]

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style (think of the *De Centro Gravitatis Solidorum* or the *Paraphrasis*), plausibly adopted also in order to facilitate a partial understanding of the texts by their patrons. In-depth studies on this topic would be welcome.

[1] F. Kieffer has discovered the payroll of 1587 independently from me, as we have learned in one of our conversations; cf. F. Kieffer, *Ferdinando I (1587-1609) et les Offices. Structure et fonctionnement de la* Galleria dei lavori, Centre d'Etudes Supérieures de la Renaissance Tours, 2012.

[2] Cf. Appendix I, I.4.4. The "*spesa*" probably refers to the number of servants ("B" for "*bocche*") and the money required to provide for them. The "*provisione*" in contrast, presumably constituted the wages for fulfilled duties and missions.

[3] Notably, the positions of the respective members practically does not change (except from cases of death, etc.), commencing with the most important member(s), i.e. the Duke's cousin(s). Also the number of servants decreases monotonously, as well as the order of magnitude of the provisions. These elements seem to justify the hypothesis that the "*liste di famiglia*" were structured in a hierarchical way.

[4] If the list of the year 1586 is taken as example, precise tasks can be associated to the first fifteen reported persons: diplomatic missions (Marchese della Rovere <Ippolito della Rovere>, Mons.r di Cagli <Bishop Paolo Marii>, S.r Ranieri <dal Monte>, Count Fabio Landriani, Count Giulio Thiene, S.r Franc.o M.a del Monte, S.r Ottaviano Fregosi, Count Mutio Beni), administrative tasks (S.r Ranieri <dal Monte>, Count Giuliocesare <Mamiani>, Count Giulio Thiene) or definite roles and professions in the organisation of the ducal office (S.r Volpella Auditore[5], S.r Cartolaro Auditore, S.r Beluccio Auditore, S.r Giulio Veterano Seg.<reta>rio, S.r Avocato Fiscale).

[6] Think of the diplomatic use made of the home-made mechanical clocks (cf. Part A, I.2) or of the fact that Francesco Maria II was exhorted by the Pope to present a proposal for the calendar reform in 1580.

But his actual role at court seems to have gone beyond this status as a kind of "court mathematician" and technical consultant of the Duke, in itself probably insufficient to explain his outstanding position in the courtly hierarchy: in fact, with seven years he had entered in the service of the three-years old Prince Francesco Maria II della Rovere, they were instructed together (both in subjects of the *trivium* as well as in horse-riding and fencing) and even ate at the same table. So, it can plausibly assumed that the spent much time together in childhood. Considering further the excellent relations between their fathers Duke Guidobaldo II and Ranieri dal Monte,[1] one of the five most important men in the Duchy, it seems clear that they were something like childhood friends (despite of the difference of their social status) and that Guidobaldo probably represented something like an elder brother to Francesco Maria II della Rovere.
In the middle of the sixties, their ways separated temporarily: Francesco Maria II went to the Spanish court at Madrid, consonant with his future duties and his father's connections to Philip II, while Guidobaldo undertook studies on philosophy and mathematics at Padua and later went to war in Hungary. But this period of distance can be interpreted as their respective preparation for their roles as adults: Francesco Maria II as Duke, Guidobaldo as courtier and military captain, with the required erudition for the cultural *milieu* of the Urbinate court,[2] and for tasks related to architecture and military engineering – just like his father had been for Guidobaldo II.
Reunited at the end of the decade, they recommenced their common studies, this time "advanced" mathematics under Commandino and possibly philosophy under Cesare Benedetti (and others). Then, they really went at war together, directed to Lepanto – yet, Guidobaldo suffered a heavy form of sciatica which impeded him to participate at the battle and, more profoundly, to copy his father's role towards the Duke: Ranieri's son had to abandon his military career. His role at court does not seem, however, to have been damaged: in 1573, he represented the Duke Guidobaldo II during his absence, was at Francesco Maria II's side during his coronation ceremony in 1574 and was nominated, shortly afterwards, the chief of his lifeguard *Lance Spezzate*. Further, he and his father constituted a kind of Francesco Maria II's representatives at Pesaro during his absence, as emerges from the letter reporting their arrest of Count de' Tommasi in 1584.
It is besides this status, connected to his extraordinary relation to Francesco Maria II della Rovere, that he additionally assumed also the role as technical consultant and "court mathematician".

[1] Ranieri had grown together with Guidobaldo II from childhood on, just as his son would have done with Francesco Maria II; cf. Appendix II, I.2.

[2] Cf. Giulio Giordani's letter to his father of December 20th 1567, BOP, ms 923 (letters without numeration, but in chronological order): the future secretary of the Duke had gone to Florence in order to study philosophy and music, "trying to return to Pesaro, endowed with those virtues which every gentleman ought to possess." See Appendix II, II.2.

Another activity of Guidobaldo can be probably explained against the background of his close connections to the Duke: the instruction of future architects and engineers. At this regard, G.G. Leonardi's statement about his personal formation under Guidobaldo and Count Giulio Thiene is particularly interesting:[1] also the latter was a member of the ducal court.[2] Is it possible that the teaching of the architect-engineers and master-technicians was a task commissioned by the Duke?

In fact, such a proceeding seems plausible: the latter was obviously highly interested in the availability of competent architects and technicians for the manifold (also large-scale) construction works in the Duchy on the one side;[3] on the other, for the manufactured mechanical clocks and scientific instruments which had a national reputation and were important instruments of the Urbinate diplomacy. Further, the military service of the Dukes of Urbino to various European major powers (Spain, Venetian Republic, Pontifical State) consisted also in the construction of defence works: in fact, the outstanding role of the Urbinate school of military engineers in and outside Italy, and especially its persistence over generations, is hardly thinkable without any form of instruction.[4]

If we accept this hypothesis, then it is highly probably that Guidobaldo was involved in such an instruction: there were few persons more suitable than Guidobaldo for this task; he was not only the undisputed authority of mathematics and mechanics in the Urbinate territory, but had also ample practise in manifold architectural disciplines, concerning hydraulic, military, civil and religious architecture. Count Giulio da Thiene had a similar profile, having been active active as architect, military engineer and mathematician; further, the activity as teacher was not unusual for the latter, since he had been involved in the mathematical formation of Francesco Maria II.[5]

Another argument in favour of the hypothesis, that the mathematical formation of engineer-architects and master-technicians was in some form institutionalised, is the fact that the lessons on mechanics continued to take place also after

[1] Cf. Part A, IV.1.2.

[2] Cf. the "payrolls" of the court: interestingly, Count Giulio Thiene was the courtier with the highest provision, cf. Appendix I, I.4.4. In-depth researches on this interesting character, active as architect, military engineer and mathematician, would be a *desideratum*.

[3] Examples of such large-scale works were the ducal villa *Vedetta*, built in the 1580s; works at the port of Pesaro, undertaken in the 1580s and in the first two decades of the seventeenth century; and works regarding military engineering.

[4] For further information about the military service of the Dukes of Urbino, including the planning and construction of defence works, cf. J. Dennistoun, *Memoirs of the Dukes of Urbino*, cit., and E. Concina, *La macchina territoriale*, cit. On the Urbinate school of military engineering, cf. F. Menchetti, *Guidobaldo del Monte nel Granducato di Toscana e la scuola roveresca di architettura militare*, cit., and I. Verstegen, *Francesco Paciotti, European geopolitics and military architecture*, in "Renaissance Studies", XXV 3 (2011), pp. 393-414.

[5] An article about this topic, related to Commandino's mathematical school, is forthcoming.

Guidobaldo's death:[1] this means that they were not strictly connected with his person. The motivation of lessons on mathematics and mechanics, therefore, does not seem to have been a possible intention of Guidobaldo to form a school around himself.

As exposed in Part A, section I.2,[2] Guidobaldo was member of the della Rovere court until about the year 1589: afterwards, increasing tensions with the Duke made him gradually retire to this feud of Monte Baroccio, where he seems to have spent consistent parts of the 1590s. Then, in the period between ca. 1597 and 1602, he substantially returned to Pesaro, again being commissioned with several tasks in the capacity of architect or relating to administrative questions.[3] Guidobaldo's withdrawal from the courtly *milieu* at Pesaro was accompanied by a growing orientation towards the Medici court: in the course of few years, he sent his son to serve the Grand Duke as *Governatore* of the Pisan fortress and *Generale dell'Arme* of the State of Pisa, went himself to inspect several Tuscan fortresses as military engineer, was among the invited guests of the Medici wedding and even acted as a kind of "art-agent" of the Florentine court.[4] Further, he was in some form also in the services of the Duke of Mantua: from a recently discovered document emerges that he was commissioned to furnish plans for the fortress of Casale Monferrato.[5]

As fundamental as Guidobaldo's connections with particularly the Urbinate courtly *milieu* were for his cultural-scientific formation,[6] the tasks he had to fulfil in this context more and more distracted him from his scientific work (cf. Part A, section I.2). But also two other aspects related to his social status absorbed consisting parts of his time, from 1587: his function as Count of Monte Baroccio and as head of one of the most influential families of the Duchy.
In consequence of being count, he had to fulfil several administrative tasks, assumed the jurisdiction over his subjects and had to care for maintenance and

[1] Cf. Part A, IV.1.2; F. Guerrini's letter to Chr. Clavius of 1607.

[2] Cf. also Appendix I, I.5.

[3] For the construction projects of 1598/99, cf. Part A, I.2. Further, from the Duke's accusal reported to Pope Clement VIII in 1602 that his cousins and Guidobaldo had influenced the jurisdiction and the administration of Pesaro, it gets clear that the Count of Monte Baroccio must have intervened in questions of political and/or administrative nature, in the period between 1597-1602.

[4] Guidobaldo's attempts to procure the Grand Duke with paintings of Federico Barocci, dating to 1602, are documented by Z. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, cit.

[5] Cf. Part A, I.2. The precise nature of his relation to the Duke of Mantua still is unclear. Studies in this regard would be welcome.

[6] Cf. Part A, chapter II.

development of his town.[1] As head of the dal Monte family, he had to see about his family's influence, and in particular about his sons' future: the positioning of his sons at various courts,[2] relevant for both purposes, required a pronounced diplomatic instinct: the seriously negative consequences, which could result from the lack of the required prudence in this context are testified by the annoyance that Francesco Maria II proved in occasion of Guidobaldo's marriage plans for a member of his family with a daughter of Count Mamiani.[3] Further, as head of one of the most influential families he frequently was approached by supplicants and acquaintances which hoped for various political, pecuniary or juridical advantages, as from his correspondence emerges.[4]

[1]For further information on this topic, cf. Appendix I, I.4.1, the records of the Council of Monte Baroccio, 1600-1622, at ACM, and G. Allegretti, *Monte Baroccio 1513-1799*, cit. Among the tasks of Guidobaldo as Count of Monte Baroccio were the control of the harvest, the control of purchase and sale of real estate, the construction of communal edifices, the collaboration with the Council of Monte Baroccio etc.

[2]The scarce information about Guidobaldo's sons permits the following assertions: Francesco Maria I must have been at the della Rovere court (cf. Appendix I, II.4), even if he does not appear on the "paylists" before the year 1608; Carlo was active as soldier in Francesco Maria II's service (cf. BOP, ms 426); Orazio was in the services of the Tuscan Grand Duke; Carlo seems to have been connected with the Marchese del Vasto (cf. Appendix II, **??**); Alessandro, and possibly also Onofrio, must have been positioned in the Vatican environment (cf. a letter from Guidobaldo to Clavius, APUG, ms 530, fol. 186r).

[3]Cf. Part A, I.2.

[4]Examples are BCF, Collezione Piancastelli, Secc. XII-XVIII busta 19; and letters of his wife Felice della Rovere dal Monte conserved at BUU, Fondo del Comune, Busta 113, fasc. 2.

VI.2 The mechanical content of the *Meditatiunculae*

Mechanics does not constitute the mathematical discipline with the main accent in the *Meditatiunculae*: notably more space is reserved to perspective and gnomonics than to mechanics with some thirty of about 240 pages. The respective entries, however, contain precious information about Guidobaldo's mechanical conceptions and aspects of his work that without the *Meditatiunculae* would not be known. Its mechanical content, thus, should not be neglected with the consideration of his mechanics.

The entries on subjects of mechanics in a large sense (i.e. including also practical questions or problems relative to the motion of bodies) are generally scattered across the whole *Meditatiunculae*, between entries on other mathematical disciplines – the only exception is constituted by pages 54-64 which all occupy, except for pp. 62/63, with mechanical problems. Despite of their apparent disjointedness, they can be associated to few mechanical subsections. For the sake of a more congruent exposition, they are assembled and exposed here in thematic, and not topographic order:
A certain number of entries deals with problems relative to the balance, both the "statical" one with references to the *Quaestiones Mechanicae*, the *Mechanicorum Liber*, and Benedetti's *Diversarum Speculationum Liber* as well as the hydrostatic one approached in two fundamentally different versions. Another group of pages testifies Guidobaldo's attempt to find a mathematical treatment of the resistance coupled with the action of mechanical machines. A third category regards entries on practical questions as the targeting with cannons, inclinations of roofs or the construction of mathematical instruments. These entries, but also other ones, for example on the measuring of the heights of towers (pp. 9-11) or on the trajectory of projectiles (p.236), show in a particularly way Guidobaldo's activity in other fields as architect or military engineer.[1] Some of the entries might be regarded as attempts of theorising his "everyday" experiences in these fields. Then, another group of pages deals with problems that actually were part of natural philosophy in those times: the question about Earth's movement and the motion of bodies, both in fluids as well as in regard of their trajectory as projectiles. A fifth class regards the theory of the *centre of gravity*. The last two groups are formed by two different approaches to the problem of the inclined plane and by drafts of propositions of the *Cochlea*, posthumously released by Guidobaldo's sons in 1609.

[1] For further information about Guidobaldo's activities and the context of his scientific work, cf. Part A, chapters I and II, as well as the sections IV.1 and V.1.

VI.2.1 Problems relative to the balance

The entries relative to the balance do not form a thematically coherent and contiguous section, but are scattered over the whole work. They concern the treatment of the balance in the *Quaestiones Mechanicae* (p. 30); a proposition contained in the chapter *De Libra* of the *Mechanicorum Liber* (pp. 31-32); a comment on the first question of the *Quaestiones Mechanicae* about the precision of small and large balances (pp. 55-56); a critique against Benedetti's treatment of the balance in Chapters II and III of *De Mechanicis* in the *Diversarum Speculationum Liber*; and finally two versions – one qualitative, the second quantitative – of the hydrostatic balance (p. 119 and pp. 232-234).

"*De Libra: Quaestiones Aristotelis de libra aliter demonstratae*" and the Aliter of Proposition VI of the *Mechanicorum Liber*

On page 30, Guidobaldo revisits the second question of the *Quaestiones Mechanicae* where Aristotle had considered two kinds of balances, according to the position of the rotation point above or below the beam. These entries show some similarity to Propositions II and III of the *Mechanicorum Liber*, so the juxtaposition of the respective passages seems advisable:[1]

Meditatiunculae, p. 30
Propositio prima
Libra horizonti aequidistans, spartum habens sursum, cum mota fuerit, in aequilibrium horizonti aequidistans redit.

Mechanicorum Liber, fol. 4r-4v
Propositio II.
Libra horizonti aequidistans, cuius centrum sit supra libram, aequalia in extremitatibus, aequaliterque a perpendiculo distantia habens pondera, si ab eiusmodi moveatur situ, in eundem rursus relicta, redibit, ibique manebit.

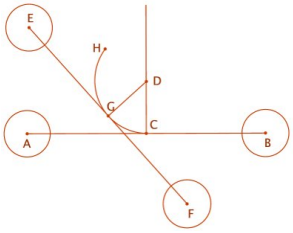

Figure VI.1: The first figure of page 31 of the *Meditatiunculae*.

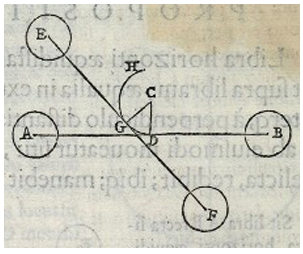

Figure VI.2: The figure of Proposition II of the *Mechanicorum Liber*.

[1] The marginal citations presented by the respective versions are inserted in the text between the signs $< . >$. The respective figures of the *Meditatiunculae* have been reproduced true to original by the Pisan *e-Labor*. We would like to thank its head Paolo Mascellani and his collaborators for having me supplied with the figures.

Sit libra ab horizonti aequidistans, cuius medium c, sitque cd ad rectos angulos ad ab, et sit cd ita cum ab connexa, ut ad ab sit semper perpendicularis. Sitque d spartum, hoc est centrum mmobile sive truttina supra libram, et in ab pondera appensa sint aequalia.

Moveatur libra, quae perveniat ad ef, tunc dc erit in dg. Et c circumferentiam circuli cgh, cuius centrum d describet.

Et quoniam in ef appensa sunt pondera aequalia, centrum gravitatis eorum erit in medio, in puncto g <per 4 primi Archimedis *De Aequeponderantibus*>.

Sed centrum gravitatis semper deorsum tendit, g igitur movebitur deorsum per circumferentiam gc, est enim d punctum immobile. Et quia infimus locus est c, ideo g semper movebitur donec redeat in c, et cum g erit in c, libra ef redibit horizonti aequidistans.

Sit libra AB recta linea horizonti aequidistans, cuius centrum C sit supra libram, sitque CD perpendiculum, quod horizonti perpendiculare erit; atque distantia DA sit distantiae DB aequalis, sintque in A, B pondera aequalisa, quorum gravitatis centra sint in A, B punctis. Moveatur AB libra ab hoc situ, puta in EF, deinde relinquatur. Dico libram EF in AB horizonti aequidistantem redire, ibique manere.

Quoniam autem punctum C est immobile, dum libra movetur, punctum D circuli circumferentiam describet, cuius semidiameter erit CD. Quare centro C, spatio verso CD, circulus describatur DGH. Quoniam enim CD ipsi librae semper est perpendicularis, dum libra erit in EF, linea CD erit in CG, ita ut CG sit ipsi EF perpendicularis. Cum autem AB bifariam a puncto D dividatur et pondera in A, B sint aequalia, erit magnitudinis ex ipsis A, B compositae centrum gravitatis in medo, hoc est in D <4 primi Archimedis *De aequeponderantibus*>. Quando libra una cum ponderibus erit in EF, erit magnitudinis ex utrisque EF compositae centrum gravitatis G.

Et quoniam CG horizonti non est perpendicularis, magnitudo ex ponderibus EF composita in hoc situ minime persistet <prima huius>, sed deorsum secundum eius centrum gravitatis G per circumferentiam GD movebitur, donec CG horizonti fiat per//pendicularis, scilicet donec CG in CD redeat.

Quando autem CG erit in CD, linea EF, cum ipsi CG semper ad rectos sit angulos, erit in AB; in quo situ quoque manebit. Libra ergo EF in AB horizonti aequidistantem redibit,

ibique manebit <prima huius>, quod demonstrare oportebat.

At first sight, an essential difference seemingly regards the suppositions on which the respective reasoning is based: while the version of the *Meditatiunculae* uses one supposition only, namely that the centre of gravity tries to reach the lowest position possible,[1] the version of the *Mechanicorum Liber* refers twice to "prima huius", i.e. to the first proposition of the chapter *De Libra*. This theorem – according to which a body is in rest if and only if the line from its suspension point to its barycentre is perpendicular to horizon – however, essentially consists in applying the third supposition of the *Mechanicorum Liber* which states that weights move downwards "according to their barycentres".[2] So, there is no fundamental difference regarding the supposition to which both versions have recourse. The only real difference, it seems, is constituted by the last passage of the *Mechanicorum Liber*-version which is missing in the other one. Anyway, the argumentation is the same, in substance, even if the version of the *Mechanicorum Liber* presents a (notably) higher degree of elaboration. This regards on the one hand the formal standpoint, as it presents the typical characteristics of a theorem according to the model of Greek mathematics, with *protasis* and *ekthesis*. On the other hand, where the *Meditatiunculae*-version omits (easy) argumentative steps, the other one reports every detail.

The treatment of the balance with rotation centre below the beam is the following:

MED, p. 30

Propositio secunda

Si vero libra habet spartum deorsum, non redit in aequilibrium sed deorsum tendit.

Sit libra *ab*, sitque *cd*, ut supra dictum est. Et sit *d* spartum sub libra.

ML, fols. 4v-5r

Propositio III.

Libra horizonti aequidistans aequalia in extremitatibus, aequaliterque a perpendiculo distantia habens pondera, centro inferne collocato, in hoc situ manebit. Si vero inde moveatur, deorsum relicta, secundum partem decliviorem movebitur.

Sit libra AB recta linea horizonti aequidistans, cuius centrum C sit infra libram; perpendiculumque sit CD, quod horizonti perpendiculare erit et

[1] The *Suppositio* simply states "Centrum gravitatis deorsum tendere". Its use, though, shows Guidobaldo's conception of an "extremal" property of the centre of gravity: "Et quia infimus locus est *c*, ideo <centrum gravitatis> *g* semper movebitur donec redeat in *c* (...)."

[2] *Mechanicorum Liber*, fol. 1v: "Secundum gravitatis centrum pondera deorsum feruntur."

distantia AD sit distantiae DB aequalis; sintque in A, B pondera aequalia, quorum gravitatis centra sint in punctis A, B. Dico primum libram AB in hoc situ manere.
Quoniam enim AB bifariam dividitur a puncto D et pondera in A, B sunt aequalia, erit punctum D centrum gravitatis magnitudinis es utrisque A, B ponderibus compositae <quarta primi Archimedis *De Aequeponderantibus*>, et CD libram sustinens horizonti est perpendicularis, libra ergo AB in hoc situ manebit.

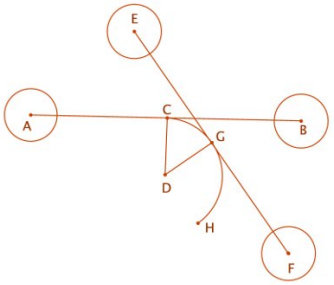

Figure VI.3: The second figure of page 31 of the *Meditatiunculae*.

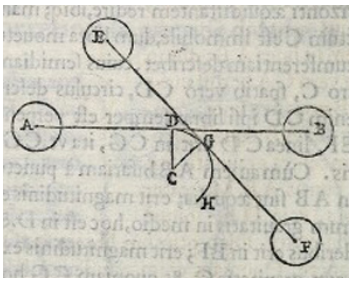

Figure VI.4: The figure of proposition III of the *Mechanicorum Liber*.

Moveatur libra ab, quae perveniat in ef. Tunc cd erit in dg, et g erit centrum gravitatis ponderum, quae sunt in e, f. Sed g deorsum tendit, cum sit centrum gravitatis. Quare deorsum per circumferentiam gh, cuius centrum d, movebitur.

Linea ergo ef, hoc est libra, in qua est punctum g, similiter deorsum movebitur. Quod erat ostendendum.

Moveatur autem libra AB ab hoc situ, puta in EF, deinde relinquatur. Dico libram EF ex parte F moveri. Quoniam igitur CD ipsi librae semper est perpendicularis, dum libra erit in EF, erit CD in CG ipsi EF perpendicularis. Et punctum G magnitudinis ex E, F compositae centrum gravitatis erit; quod dum movetur, circuli circumferentiam describet DGH, cuius semidiameter CD et centrum C. Quoniam autem CG horizonti non est perpendicularis, magnitudo ex EF ponderibus composita in hoc situ minime manebit, sed secundum eius gravitatis centrum G deorsum per circumferen-

> tiam GH movebitur. Libra ergo EF ex parte F deorsum movebitur; quod demonstrare oportebat.

Again, there is the same situation: the case of the rest is not regarded in the *Meditatiunculae*-version, which, moreover, does not present a serious of formal characteristics that the other one has instead. Yet, there is no substantially new or different element between the arguments.
Immediately after the second proposition of the *Meditatiunculae*-version, there is the following comment, which, at first sight, seemed to permit a dating *a quo* of the text:

> It is good to know that Aristotle does not expose this question in this way, namely that ef turns downwards, but he claims that it stays at rest. This has not been noticed by Alexander Piccolomini in his paraphrase and by that one <Oreste Biringucci> of Siena who translated it in our language;[1] they adduced a nevertheless true conclusion, different from the problem in Aristotle. Yet, how Aristotle's reasoning has to be understood, is treated in the chapter *De Libra* of our *Mechanicorum Liber*.[2]

The citation of the Italian translation of Piccolomini's paraphrase, seemed to make this page datable to a period successive to the year 1582. However, as an analysis of the page in question reveals, this quoted passage is written with different ink and pen: so, it was written in a second moment and does not permit to date with certainty the propositions on the balances to a period later than 1582.
So, what is the relation of between the *Meditatiunculae*-versions on the one hand and the ones in the *Mechanicorum Liber*? An even more puzzling situation is constituted by the successive two pages: pages 31 and 32 report an entry, which is almost identical with the aliter of Proposition VI *De Libra* in the *Mechanicorum Liber*. Before we come to some considerations about this fact, we report the text of both versions:

[1] Guidobaldo obviously refers to Piccolomini's comment of the *Quaestiones Mechanicae*, *In Mechanicas Quaestiones Paraphrasis* (Roma, 1547) and to its Italian translation by O.V. Biringucci (Roma, 1582).

[2] *Meditatiunculae*, p. 30: "Novisse tamen oportet Aristotelem non proponere hanc quaestionem hoc modo, nempe uf ef deorsum tendat, sed asserit eam manere. Quod quidem Alexander Piccolomineus in sua parafrasi, Senensisque ille qui eam lingua nostra vernacula [venit], minime animadverterunt, quippe qui conclusionem quamvis veram a problemate tamen Aristotelis diversam attulerunt. Quomodo autem Aristotelis sententia sit intelligenda, nos in nostro *Mechanicorum Libro* in tractatu *De Libra* docuimus."

Meditatiunculae, pp. 31/32

Pondera aequalia in libra appensa eam in gravitate proportionem habent, quam distantiae, ex quibus appenduntur.
Sit libra bac, quae suspendatur in a et ex punctis b, c appendantur aequalia pondera g, f. Dico pondus f ad pondus g eam in gravitate proportionem habere, quam habet distantia ca ad distantiam ab.

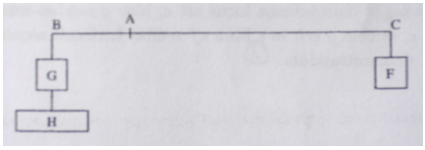

Figure VI.5: The figure of page 31 of the *Meditatiunculae*.

Fiat ut ba ad ac, ita pondus f ad h, et h appendatur in b. Pondera igitur hf aequeponderabunt ex a. Sed cum pondera f, g sint aequalia, habebit pondus h ad pondus g eandem proportionem, quam habet ad f. Ut igitur ca ad ab, ita est h ad g. Et quoniam pondera g, h in eodem puncto b sunt appensa, ideo in eadem proportione erit gravitas ad gravitatem, ut magnitudo ad magnitudinem: **hoc est, si pondus h triplum sit ponderis g, gravitas etiam ponderis h tripla erit ponderis g.**
Quare ut ca ad ab, ita est gravitas ponderis h ad gravitatem ponderis g. Sed gravitas ponderis f in c est aequalis gravitati ponderis h in b. Gravitas igitur ponderis f ad gravitatem ponderis g est, ut ca ad ab, videlicet ut distan-

Mechanicorum Liber, fol. 35r

Pondera aequalia in libra appensa eam in gravitate proportionem habent, quam distantiae, ex quibus appenduntur.
Sit libra BAC, cuius centrum A in punctis vero BC pondera appendantur aequalia G, F; sitque primum centrum A utcunque inter B, C. Dico pondus F ad pondus G eam in gravitate proportionem habere, quam habet distantia CA ad distantiam AB.

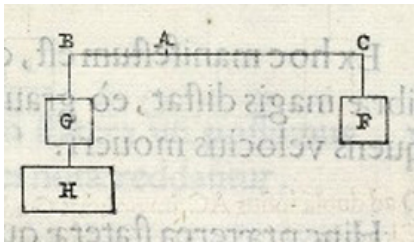

Figure VI.6: Proposition VI of *De Libra*.

Fiat ut BA ad AC, ita pondus F ad aliud H, quod appendatur in B: pondera HF ex A aequeponderabunt. Sed cum pondera F, G sint aequalia, habebit pondus H ad pondus G eandem proportionem, quam habet ad F. Ut igitur CA ad AB, ita est H ad G. Ut autem H ad G, ita est gravitas ipsius H ad gravitatem ipsius G, cum in eodem puncto B sint appensa.

Quare ut CA ad AB, ita gravitas ponderis H ad gravitatem ponderis G. Cum autem gravitas ponderis F in C appensi sit aequalis gravitati ponderis H in B, erit gravitas ponderis F ad gravitatem ponderis G, ut CA ad AB, vide-

tia ad distantiam. //

Si vero libra bac secetur utcumque in d et in d, c appendantur pondera aequalia e, f. Dico similiter pondus f ad pondus e eam in gravitate proportionem habere, quam habet distantia ca ad distantiam ad.
Fiat ab aequalis ad, et in b appendatur pondus g aequale utrique ponderi e et f. Quoniam enim ab est aequalis ad, pondera g, e aequeponderabunt. Sed cum gravitas ponderis f ad gravitatem ponderis g sit, ut ca ad ab, et gravitas ponderis e sit aequalis gravitati ponderis g, gravitas ergo ponderis f ad gravitatem ponderis e erit, ut ca ad ab, hoc est ut ca ad ad; quod erat ostendendum.

licet ut distantia ad distantiam, quod demonstrare oportebat.
Si vero libra BAC secetur utcunque in D et in D, C appendantur pondera aequalia E, F. Dico similiter ita esse gravitatem ponderis F ad gravitatem ponderis E, ut distantia CA ad distantiam AD.
Fiat AB aequalis ipsi AD, et in B appendatur pondus G aequale ponderi E et ponderi F. Quoniam enim AB est aequalis AD, pondera G, E aequeponderabunt. Sed cum gravitas ponderis F ad gravitatem ponderis G sit ut CA ad AB, et gravitas ponderis E sit aequalis gravitati ponderis G, erit gravitas ponderis F ad gravitatem ponderis E, ut CA ad AB, hoc est ut CA ad AD; quod demonstrare oportebat.

Apparently, the two versions are practically identical, even in regard of the very wording. The *Meditatiunculae*-version does not present any innovation compared to the other one. The only real difference is a numerical example which we have emphasised in bold font.

We should say a word about the exterior form of these passages: in difference to many other pages of the *Meditatiunculae*, the ones in question here do not present drafts, but expose well-conceived argumentations written in a tidy, regular handwriting, practically without any corrections or marginal additions. The only exception is constituted by the last two phrases of page 32: The original version, which we will expose in the following – emphasising in bold font the differences to the corrected version-, is corrected, again, by a different ink, different, though, also from the ink with which is written the comment on Piccolomini's and Biringucci's paraphrase on the *Quaestiones Mechanicae* on page 30:

> Quoniam enim ab est aequalis ad, pondera g, e **in** a aequeponderabunt. Sed cum gravitas ponderis f ad gravitatem ponderis g sit, ut ca ad ab, et gravitas ponderis e sit aequalis gravitati ponderis g, gravitas ergo ponderis f ad gravitatem ponderis e erit, ut ca ad ab, **sed** ad **est aequalis ipsi** ab **quare ita est gravitas ponderis** f **ad gravitatem ponderis** e**, ut distantia** ca **ad distantiam** ad; quod erat ostendendum.

So, beyond the cancelling of "in *a*" at the beginning, the phrase "sed *ad* est .... distantiam *ad*" was scratched through and has been substituted by "hoc est ut *ca* ad *ad*" between the lines: by this operation, the two passages are exactly identical, with the exception of an "ergo" and the position of the verb "erit".

So, how can these three pages be interpreted? As the juxtapositions of the texts have evidenced, they present curious analogies with passages of the *Mechanicorum Liber*: page 30 presents all substantial steps and arguments contained in the more elaborate version of the *Mechanicorum Liber*, and pages 31-32 expose, with very few exception, literally the identical text of the aliter of Proposition VI.
Did Guidobaldo revisit propositions contained in his *Mechanicorum Liber*? But if he had done so, what might have been the sense, given that he does not introduce any conceptual or argumentative modification? Not to speak about the almost literally identical version of the aliter. This is a rather puzzling question, which hardly could be conciliated with the dating of the notebook in the period of 1586/87-1593.
Are we in front of material which stems of a time before the publication of the *Mechanicorum Liber*?[1] This would obviously entail far-reaching consequences for the valuation of the *Meditatiunculae...* Here, though, is not the place to analyse the question in a more detailed way.

Comment on the first question of the *Quaestiones Mechanicae*

On pages 55-56, Guidobaldo deals with the first question of Aristotle's *Quaestiones Mecanicae*, according to which large balances would be more precise than smaller ones. He seems to agree with this statement and transforms Aristotle's argumentation in a mathematical demonstration.

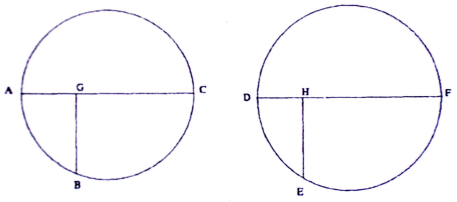

Figure VI.7: The figure of page 55 of the *Meditatiunculae*.

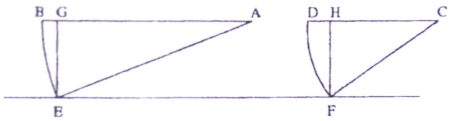

Figure VI.8: The figure of page 56.

The argumentation line of Aristotle was the following: bodies move more easily in the "natural direction" than in an "unnatural direction". For balance beams, the direction of the "natural movement" is along the tangent, while the component of the movement towards the centre of the circle represents the "unnatural"

[1]Note that, before page 30, there is no citation of any work published after the 1570s..

one. For larger balances, the relation between natural movement and unnatural one is bigger than for smaller balances, therefore the weights on it move more easily and consequently, as Aristotle claims, large balances are more sensitive and thus more precise.[1]
Now, the argumentation is, from a mathematical standpoint, not always very clear in the *Quaestiones Mechanicae*. This might have been the reason, why Guidobaldo proved the key arguments of the Aristotelian reasoning:
First (on page 55), Guidobaldo deals with a purely technical question: considering two circles of different size, DEF bigger than ABC (cf. figure VI.7), he perpendicularly applies to the respective diameters the equal lines GB, HE. He shows that $BG : GA > EH : DH$ (with recourse to propositions of the sixth book of the *Elements*).[2]
Then (on page 56; cf. figure VI.8), he comes to the interpretation of this fact: he considers two balance arms BA and DC, the first one longer than the second. May they move in EA and CF, their endpoints covering the same vertical distance EG and HF. Now, as shown on page 55, $GE : BG > HF : DH$. But since $GE : BG$ is the relation of the natural movement of a weight in B to its unnatural movement (and analogously for $HF : DH$, the same weight in B is moved more "according to nature" than in D.

Against Benedetti's *Diversarum Speculationum Liber*

Pages 145/46 form a thematic unit containing Guidobaldo's critique against the two fundamental "chapters" of Benedetti's mechanical theory,[3] exposed in the section *De Mechanicis* of the *Diversarum Speculationum mathematicarum et physicarum Liber* (1585).[4] Between the two pages a folio, by a later hand nominated

[1] Cf. Arist., *Mech.*, 849a 6-17; Hett's translation of the passage in question is: "Now if of two objects moving under the influence of the same force one suffers more interference, and the other less, it is reasonable to supose that the one suffering the greater interference should move more slowly than that suffering less, which seems to take place in the case of the greater and the less of those radii which describe circles from the centre. For because the extremity of the less is nearer the fixed point than the extremity of the greater, being attracted towards the centre in the opposite direction, the extremity of the lesser radius moves more slowly. This happens with any radius which describes a circle; it moves along a curve naturally in the direction of the tangent, but is attracted to the centre contrary to nature."

[2] For $GB = HE$, Guidobaldo confines himself to show that $DH < AG$. The technical details are not of interest here.

[3] Correspondingly, pages 145 is entitled "Contra Cap.<ut> 2 Io.<hanni> de Benedect.<is> *De Mechan.<icis>*", page 146 "Contra Cap.<ut> 3 eiusdem".

[4] Thanks to a lucky coincidence, Guidobaldo's copy of the *Diversarum Speculationum Liber* has reappeared and could be acquired by the Max-Planck-Institut für Wissenschaftsgeschichte. Its numerous marginal notes make it a precious source of Guidobaldo's derogatory consideration of Benedetti's mechanics. Cf. J. Renn, P. Damerow, *Guidobaldo's Marginal Notes on Benedetti's* Diversarum speculationum, in *Guidobaldo del Monte (1545-1607). "Mathematics" and technics from Urbino to Europe*, cit.

"145bis", has been stuck in by Guidobaldo. It deals with the problem of the inclined plane and will be analysed in subsection VI.2.6.[1]
As already exposed before,[2] Benedetti had stated in *Caput* II of the section *De Mechanicis* that the effective heaviness of a weight, fixed at the inclined arm of an angular balance, is measured by its vertical projection to the horizontal line. So, according to the Venetian scholar, any weight has the same "effect" if placed in F (on the balance arm FB), in u (on the balance arm Bu) or in e (balance arm Be), while its counterweight remains invariant and fixed in D on the other balance arm BD (cf. figure VI.9).

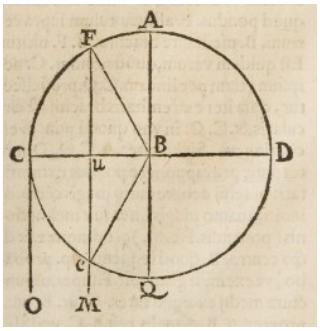

Figure VI.9: The figure of Benedetti's second chapter of *De Mechanicis*.

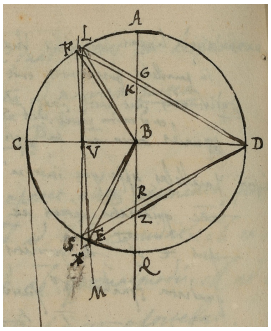

Figure VI.10: Guidobaldo's respective figure in the *Meditatiunculae*.

Guidobaldo denied the correctness of this statement using an incoherency in Benedetti's argumentation: in fact, the latter had characterised the line FuM as converging to the centre of the world.[3] So, Guidobaldo really took Benedetti at his word – Guidobaldo was familiar with this procedure: already in the *Mechanicorum Liber* he had shown that Tartaglia's argumentation about the isostatic balance was wrong if converging lines of action were considered – and contrasted the inclined line FuM with the perpendicular AQ (cf. figure VI.10). He then proved that weights do have the same effective gravity, if located along the parallel AQ, i.e. in L, u and S. So, Guidobaldo's conclusion is exactly what Benedetti

[1]The treatment of the inclined plane on page 145bis presents notable similarities with Galileo's, exposed in *Le Mecaniche*. Despite of the different topic, it is connected to the critique versus Benedetti: one of the key elements of the treatment of the inclined plane is the measuring of the effective heaviness of a weight attached to a bent balance arm by the perpendicular to the horizontal. This explains why Guidobaldo has stuck in the folio at this place.

[2]For further information about Benedetti's mechanical work, cf. Part A, III.5.

[3]In fact, Benedetti stated on page 142 of the *Diversarum Speculationum Liber*: "Proportio ponderis in C ad idem pondus in F erit quemadmodum totius brachii BC ad partem Bu positam inter centrum et *lineam FuM inclinationis, quam pondus ab extremitate F liberum versus mundi centrum conficeret.*" The emphasis is ours.

had claimed, too, only that the former avoids the later's incoherent consideration of FuM as sometimes vertical and sometimes converging.[1]
Guidobaldo's demonstration of this fact is elementary: be LuS parallel to AQ, while from u a line converging to the centre of the world be drawn that intersects the circumference in the points F on the upper semicircle and M on the lower one, cf. figure VI.10. Connecting S with D, $SR : RD = uB : BD$ for the theorem of intersecting lines. So, if in S and u is fixed the same weight with inverse proportion $BD : uB$ to the one in D, both the angular balance SBD and the straight one uBD are in equilibrium, for the law of the lever, if suspended in B.[2]
Thus, the same weight has the same effective heaviness in u and in S. But not the same as in E, as Guidobaldo interprets Benedetti's statement: he confutes this geometrically, prolonging LS and DE to the intersection point X and then considering the respective relations between the lines between X, D and S, D.
The analogous reasoning shows that the weight in L has the same effective heaviness as in u, while in F it would be heavier.
In a conclusive comment, Guidobaldo criticises Benedetti's argumentation for having identified the situation of the weight suspended with a cord from F on the balance FBD and hanging in u, with the situation when the same weight is situated in u, directly fixed at a balance uBD.[3]

Page 146 then deals with *Caput* III of *De Mechanicis* which exposes the fundamental working concept of Benedetti's mechanical theory: how can the effect of forces or weights be measured which act along arbitrary directions? According to the Venetian mathematician, it can be measured by the perpendicular drawn from the centre of rotation of the respective mechanical device (balance, lever) to the line of action of the force in question: so, if a weight or force acted in c along ca, its "effect" would be measured by the perpendicular ot, where o is the rotation centre of the balance/lever boa (cf. figure VI.11). If the same segment

[1] In effect, Benedetti remains unclear, and maybe willingly ambiguous in respect of the question if the lines of action have to be considered as parallel or converging. In *Caput* I and II, he substantially takes into account parallel lines of action, but contemporaneously admits that they form an angle (insensibly) smaller than 180 degrees. Then, in *Caput* VIII, where he criticizes Tartaglia and Jordanus, he bases his reasoning unto the consideration of *converging* lines, moreover claiming that "every error committed by them is due to their consideration of *parallel* lines" (p. 150). So Guidobaldo, even if he again is meticulous about the question of parallelism and convergence of the lines of action, is not completely mistaken by revealing this argumentative incoherency of Benedetti. A more detailed of this question of the lines of action is contained in Part B, II.4.6.

[2] This is evident for the straight balance uBD. For the angular balance, the following argumentation holds: R is the barycentre of the two weights in u and D. Consequently, the bent balance SBD, held in B, is in equilibrium, since its suspension point B lies vertically above its barycentre R – this fact is demonstrated in the first proposition of the *Mechanicorum Liber*.

[3] In effect, Benedetti had not furnished any explication for this identification at the beginning of *Caput* II.

$oi = ot$ were applied to the actual beam oa, the weight/force in c acting along ac would have the same effect as if it operated in i along the perpendicular.
Again, Guidobaldo did not agree with Benedetti's argumentation: in fact the latter had not demonstrated the crucial step, but had invoked a "quadam communi scientia',[1] where a motivation would have been anything but trivial. In fact, Benedetti's admittedly interesting attempt of this kind of decomposition of forces is erroneous, as his incorrect solution of the case of the isostatic balance (chapter VII-VIII) reveals.

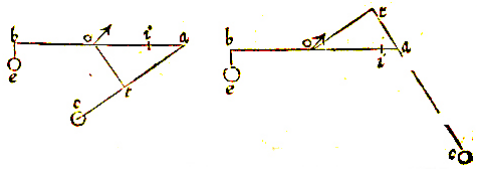

Figure VI.11: The two cases of the third chapter in *De Mechanicis*, according to the angle oac.

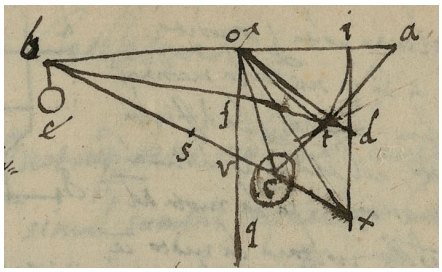

Figure VI.12: Guidobaldo's figure of the first case, i.e. with oac acute-angled.

Guidobaldo's argumentation confutes that the same weight in t, attached to the angular balance/lever bot, has the same effective heaviness as in i, if attached to the straight balance/lever boi – ignoring, however, the fact that Benedetti had postulated different lines of action for the two cases. With this misinterpretation, it does not take much to evidence that bf and fd have the same relation as bo and oi, while bf and ft have not (cf. figure I.33). So, the same weight in d and i, but not in t, would counterbalance the weight e in b – obviously if the lines of actions of the weights in d and i are assumed to have the *same* direction, contrary to what Benedetti had presumed.
After having analysed also the analogous second case of an obtuse angle bac, Guidobaldo admitted at the end of his argumentation that Benedetti's reasoning might be true for the case in which for example a man pulls with a certain force c along tc. Conclusively, Guidobaldo criticises the use of arguments having recourse to "*communis quadam scientia*", deeming it beneath an expert mathematician who in contrast would have to base himself upon rational conclusions.

Guidobaldo confines his critique to chapters II and III of Benedetti's *De Mechanicis*: as the successive chapter substantially have recourse to them as theoretical foundation, the confutation of only these two was sufficient to challenge

[1]Benedetti, in effect, had referred, as he is used to, to 'communi quadam scientia' in his motivation that the weight in i, acting along the perpendicular, had the same effect as in t on the bent balance/lever, acting along tc.

the rest of Benedetti's treatment:[1] it seems that Guidobaldo paid particular regard to chapter VII and VIII were Benedetti treated the isostatic balance and came to a solution differing from his own of the *Mechanicorum Liber*.[2]

The problem of king Hieron's crown and the hydrostatic balance

The *Meditatiunculae* contain two very different approaches to the problem of how to determine the composition of a mixed body. The famous story about the crown of king Hieron, transmitted by Vitruvius, is the basis of Guidobaldo's considerations on pages 119-20. The approach to the same problem at the end of the notebook, on pages 232-234, is notably different, not only in regard of the formalisation grade, but also in the very way which physical magnitudes has to be measured in order to determine the composition of the mixture.

The first version (pages 119-20), entitled "How Archimedes has found how much gold and silver was in the crown of Hieron, king of Syracuse",[3] is in many respects a extraordinary entry of the *Meditatiunculae*: it does not follow the model of a Greek demonstration, it does not even present any demonstrative structures at all, but substitutes this with numerical examples and a conversational argumentative style. A confirmation of the low formalisation level of the argumentation in question is the use of the Italian, not Latin language.

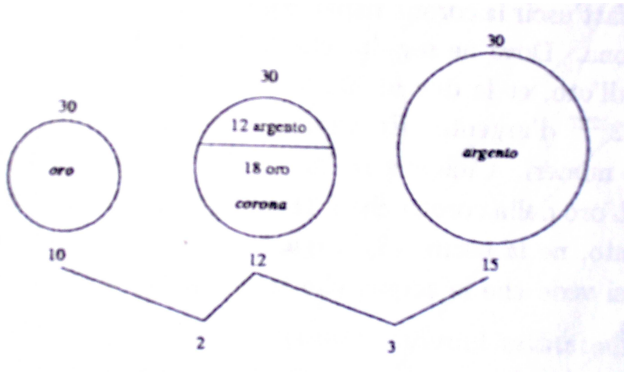

Figure VI.13: The numerical example for the problem of Hieron's crown.

The basic idea of the proceeding of finding the quantitative material composition of a mixture, is the immersion of the body in question in a brimful container of water and to measure the weight of the water flown out. So, if a certain body

[1] In fact, the marginal note of p. 143 (unfortunately cut off) of his copy of the *Diversarum Speculationum Liber* seems to claim exactly this: "In his duobus cap.<itibus> fundantur omnes authoris demonstrationes, ita ut quorum cognita falsitate omnia ..."

[2] A more detailed analysis of this topic is exposed in Part B, I.

[3] Cf. *Meditatiunculae*, p.119: "Per trovar com'Archimede ritrovò quant'oro et argento era nella corona di Hierone Re di Siracusa".

is supposed to be composed by gold and silver, two other bodies respectively of pure gold and silver, and with the same gravity that the supposed mixture, are similarly immersed, under measuring of the quantity of water run out. So, if the purely golden body has extruded 10 *libre* of water, the mixture 12 and the purely silver body 15, then the mixture will be composed by 3(=15-12) parts of gold and 2(=12-10) parts of silver.
Instead of trying to create a geometrical model of the situation, Guidobaldo tries to motivate this fact by a lengthy conversational passage:

> Perché essendo che l'acqua che fece uscire l'oro schietto sia 10 e quella della corona sia 12, per l'essere il 12 maggiore di 10 ne seguita che la corona sia di maggiore quantità di corpo, che non è l'oro schietto. E perché sono di trenta libre tutti due, adunque la maggioranza del corpo della corona nasce dall'argento che è in essa. E per conseguenza quel di più d'acque che fece uscir la corona che è 2, nasce dall'argento, che è nella corona. Per l'istessa ragione la quantità // dell'acque della corona che è 12 per essere minore del 15 che è quella dell'argento schietto, arguisce che ...

This passage is worth to be exposed, particularly for its contrast with the treatment of the same problem on pages 232-234. A separated comment on the bottom of page 120 deserves attention: it emphasises the technical difficulties of this method, and refers to another approach on page 233. This is clearly a later addition, when the version of page 233 had been already composed.

The hydrostatic balance. Guidobaldo's occupation with the hydrostatic balance begins with page 232, entitled "Making known the gravities' proportion of any body heavier than a fluid to the fluid with a balance".[1] It is written in Latin, presents an ekthesis, cites used propositions of other works and proceeds with rigorous geometrical argumentations – in difference to the version of pages 119-20. The statement is that the gravity of A is to the gravity of the fluid having the same "volume"[2] like BD to FD; this proportion would depend only on the material of A – therefore, the hydrostatic balance can be used to identify the material composition of the weight A.
For the exposition of Guidobaldo's reasoning, we adopt the following notation: $gr(A)$ may indicate the gravity of A outside the fluid, $gr(\overline{A})$ the gravity of A immersed in the fluid, $gr(\widetilde{A})$ the gravity of a quantity of fluid of equal volume than A and $gr_x(E)$ the "effective gravity" (i.e. the *proto-moment* of E in the point x.
Now, E in D may equiponderate A outside the fluid and E in F A when it is

[1] *Meditatiunculae*, p.232: "Gravitatum proportionem cuiuslibet gravis humido gravioris ad humidum libra notam reddere."

[2] The notion *volume* is absent in Guidobaldo's argumentation. He calls it "*moles humidi*".

immersed: so, because of $gr(A) = gr_d(E)$ and $gr(\overline{A}) = gr_f(E)$, we have $gr(A) : gr_d(E) = gr(\overline{A}) : gr_f(E)$ and, *permutando*, $gr(A) : gr(\overline{A}) = gr_d(E) : gr_f(E)$. Combining this with $gr_d(E) : gr_f(E) = bd : bf$ (Prop VI of the *Mechanicorum Liber*),[1] we obtain

$$gr(A) : gr(\overline{A}) = bd : bf. \ (*)$$

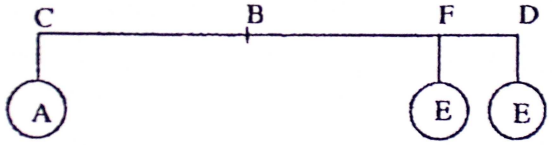

Figure VI.14: The hydrostatic balance: the weight E equilibrates the body A: E in F when A is immersed in the fluid, and in F when it is not.

According to Archimedes's law of buoyancy, $gr(A)$ is equal to $gr(\overline{A}) + gr(\widetilde{A})$. With $gr(\overline{A}) = gr_f(E)$ and $gr(\overline{A}) + gr(\widetilde{A}) = gr_d(E)$, so (*) yields $gr(\overline{A}) : (gr(\overline{A}) + gr(\widetilde{A}) = bf : bd$ and, by *convertendo* and *dividendo*,

$$gr(\overline{A}) : gr(\widetilde{A}) = bf : fd. \ (**)$$

By combining *ex aequali* (*) and (**), we obtain

$$gr(A) : gr(\widetilde{A}) = bd : fd, \ q.e.d.$$

The left side of this last relation depends, for a given fluid, only on the material of A (modernly spoken, on its *specific weight*): therefore the hydrostatic balance is adapted for measuring the material combination of the weight in A.
Guidobaldo demonstrates in an *aliter* that this procedure is independent from the order in which A is considered as immersed or not.

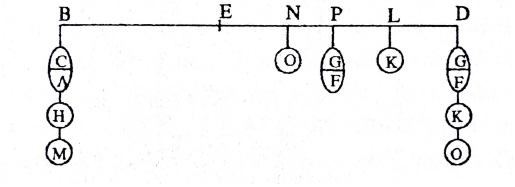

Figure VI.15: The figure of page 233.

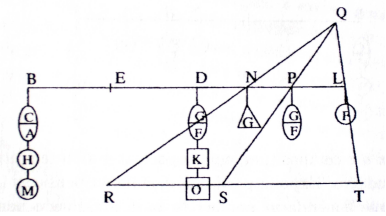

Figure VI.16: The figure of page 234: the lines OR, OS, OT serve to magnify the scale.

[1] This is part of Guidobaldo's attempts to formalise the concept of *proto-moment*, cf. Part B, chapter II, particularly II.4.

After this preparatory proposition, Guidobaldo proves on page 233 how two find the proportions of two materials that constitute a body, under the title "*Mixti proportionem invenire*". Be AC a body composed by two materials of gravity A and C, fixed in b to the balance BED with fulcrum E (cf. figure VI.15). And be in d a weight GF which equiponderates AC. Be FG imagined to consist of two separate weights K and O, and CA of H and M: H in b may be equilibrated by K, in d, and analogously M in b by O in d.
Now, if H is immersed in the fluid, K may equilibrate it in l; M immersed may be equilibrated by O in n and AC immersed by FG in p. The hypothesis is that $gr(A) : gr(C) = np : pl$.
Under these circumstances AC in b, immersed in the fluid, is equilibrated, on the one hand, by O (or G) in n and K (or F) in l together, and on the other hand by GF, i.e. by K and O together, in p. Therefore, with the notation of above, $gr_l(F) + gr_n(G) = gr_p(FG)$. So, the fifth proposition *De Libra* of the *Mechanicorum Liber* states that

$$gr_l(F) : gr_n(G) = np : pl. \ (***)$$

On the other side, $gr_l(F) = gr(A)$ and $gr_n(G) = gr(C)$, so $gr_l(F) : gr_n(G) = gr(A) : gr(C)$. Combining this with (***), we obtain

$$gr(A) : gr(C) = np : pl, \ q.e.d.$$

After an *aliter*, Guidobaldo deals with the practical realisation of such a measurement, interestingly in Italian now. As the the intervals np, pl can result very little, or almost equal, one could magnify the scale (cf. figure VI.16): if one considers another scale parallel to nl, and connects, from a certain point O, n, p and l with r, s and t, the ratio of np to pl is equal to the one of rs to st. By the choice of the distance of rt to np, this scale can be magnified to a seize that permits the measurement of $rs : st$, i.e. $np : pl$.
Another possibility to measure $np : pl$ would consist in winding around the balance a metal wire – or a "guitar string" so that the windings touch each other. And so, one could count the number of windings, proportional to the single intervals.[1]

This last paragraph presents a puzzling similarity of Galileo's treatise *Bilancetta*, dedicated to the description of the hydrostatic balance: therein, we find the same idea of winding a metal wire around the balance, in order to measure with exactness the relation called above $np : pl$:

> To construct this balance, take a bar at least two *braccia* long â the longer the bar, the more accurate the instrument. Suspend it in its

[1]This last passage reads (cf. *Meditatiunculae*, p. 234): "Poi si potrà pigliar un bastione diritto et avvolgergli atorno una corda di citara ben sottile, e che le psire si tocchino l'un l'altra, che per esser pari, si potrà veder quante spire siano np, pl overo rs, st. E così, quanto comporta l'atto pratico, si averà in numeri la proportion dell'oro e dell'argento della magnitudine di AC."

middle point; then adjust the arms so that they are in equilibrium, by thinning out whichever happens to be heavier; and on one of the arms mark the points where the counterpoises of the pure metals go when these are weighed in water, being careful to weigh the purest metals that can be found. Having done this, we must still find a way by which easily to obtain the proportions in which the distances between the marks for the pure metals are divided by the marks for the mixtures. This, in my opinion, may be achieved in the following way.

On the marks for the pure metals wind a single turn of very fine wire, and around the intervals between marks wind a brass wire, also very fine: these distances will be divided in many very small parts. Thus, for instance, on the marks e, f I wind only two turns of steel wire (and I do this to distinguish them from brass); and then I go on filling up the entire space between e and f by winding on it a very find brass wire, which will divide the space ef into many small equal parts. When then I shall want to know the proportion between fg and ge I shall count the number of turns in fg and the number of turns in ge, and I shall find, for instance, that the turns in fg are 40 and the turns in ge 21, I shall say that in the mixture there are 40 parts of gold and 21 of silver.

Here we must warn that a difficulty in counting arises: Since the wires are very fine, as is needed for precision, it is not possible to count them visually, because the eye is dazzled by such small spaces. To count them easily, therefore, take a most sharp stiletto and pass it slowly over the said wires. Thus, partly through our hearing, and partly through our hand feeling an obstacle at each turn of wire, we shall easily count said turns. And from their number, as I said before, we shall obtain the precise quantity of pure metals of which the mixture is composed. Note, however, that these metals are in inverse proportion to the distances: Thus, for instance, in a mixture of gold and silver the coils toward the mark for silver will give the quantity of gold, and the coils toward the mark for gold will indicate the quantity of silver; and the same is valid for other mixtures.[1]

[1]G. Galileo, *Opere*, vol. I, *Bilancetta* (pp. 213-232): "Per fabricar dunque la bilancia, piglisi un regolo lungo almeno due braccia, e quanto più sarłungo pišarà esatto l'instrumento; e dividasi nel mezzo dove si ponga il perpendicolo; poi si aggiustino le braccia che stiano nell'equilibrio, con l'assottigliare quello che pesasse più; e sopra l'uno delle braccia si notino i termini dove ritornano i contrapesi dei metalli semplici quando saranno pesati nell'aqqua, avvertendo di pesare i metalli più puri che si trovino. Fatto che sarà questo, resta a ritrovar modo col quale si possa con facilità aver la proporzione, secondo la quale le distanza tra i termini dei metalli puti verranno divise dai segni dei misti; il che, al mio giudizio si conseguirà in questo modo: Sopra i termini dei metalli semplici avvolgasi un sol filo di corda d'acciaio sottilissima, ed intorno agli intervalli, che tra i termini rimangono, avvolgasi un filo di ottone pur sottilissimo; e verranno

Now, the fact that both treatments contain this rather extravagant detail is another clue of a scientific collaboration between Guidobaldo and Galileo. Surely, at the present state of the art, there is no possibility to state with certainty of which nature this collaboration was, particularly in this case of the hydrostatic balance. In-depth studies on this topic would be a *desideratum*.

VI.2.2 Resistance of mechanical machines

The three pages 59-61 are dedicated to the attempt to find a geometrical treatment of the resistance occurring during the action of certain mechanical machines. Page 60 regards machines whose working implies the rotation of wheels around an axis, like pulleys or winches. Guidobaldo regards two concentric wheels with different diameters $AB > CD$ and common axis EF (cf. figure VI.17). Two equal weights are supposed to be fixed in A and C. Obviously, the *potentiae sustinentes* holding in equilibrium these weights in F, B are equal.[1] But the *potentiae moventes*, required to move these weights would be different, the one in B being smaller than the one in D: in effect, the material resistance during the operation of the machine derives from the contact and friction between the axis EGF and the respective wheels. Guidobaldo assesses this resistance to be proportional to the respective radii: the friction occurring during the movement of the wheel DC is determined by the relation $GF : GB$, while the one with the movement of AB is given by $GF : GB$. Since $GF : GD < GF : GB$, the force required to exceed the resistance is bigger in D than in B. Therefore, when two equal weights are fixed in A, C, a bigger force is required to move them from D than in B.

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tali distanza divise in particelle uguali. Come, per essempio, sopra li termini e, f avvolgo due gili solo di acciaio (e questo per distinguerli dall'ttone); e poi vo riempendo tutto lo spazio tra e, f con l'avvolgervi un filo sottilissimo di ottone, il quale mi dividerà lo spazio e, f in molte particelle uguali; poi quando io vorrò sapere la proporzione che è tra fg, ge, conterò i fili fg ed i fili ge, e trovando i fili fg esser 40 ed i ge esser, per essempio 21, dirò nel misto esser 40 di oro e 21 di argento. Ma qui è da avvertire che nasce una difficoltà nel contare: peroché, per essere questi fili sottilissimi, come si richiede all'esquisitezza, non è possibile con la vista numerarli, però che tra sì piccoli spazi si abbaglia l'occhio. Adunque, per numerargli con facilità, piglisi uno stiletto acutissimo, col quale si vada adagio adagio discorrendo sopra detti fili; ché così parte mediante l'udito, parte mediante il ritrovar la mano ad ogni filo l'impedimento, verranno con facilità detti fili numerati: dal numero dei quali, come ho detto sopra, si averà l'esquisita quantità dei semplici, de' quali è il misto composto. Avvertendo però, che i semplici risponderanno contrariamente alle distanze: come, per esempio, in un misto d'oro e d'argento, i fili che saranno verso il termine dell'argento ci daranno la quantità dell'oro. E quelli che saranno verso 'l termine dell'oro ci dimostreranno la quantità dell'argento; ed il medesimo intendasi degli altri misti." The English translation is made by L. Fermi, G. Bernardini and C.S. Smith.

[1] For further information of Guidobaldo's distinction between *potentia sustinens* and *potentia movens*, cf. Part A, IV.2.4.

Pages 60-61 deal with the resistance opposed by a small obstacle (e.g. a stone) against the translation of a cylindrical body ("*scytala*") along the plane.[1]
Let BEF and DGH be the cross sections of two such bodies supposed to have equal gravity (despite of their different size), with radii $AB < CD$; let AF, CH be drawn from the centres A, C parallel to the horizontal; and let N, O be two obstacles of the same height BK (cf. figure VI.19). Guidobaldo states, on page 61, that then a minor force is required to move the cylindrical body DGH over O than BEF over N.

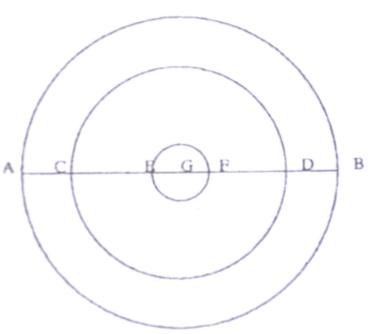

Figure VI.17: The figure of page 59.

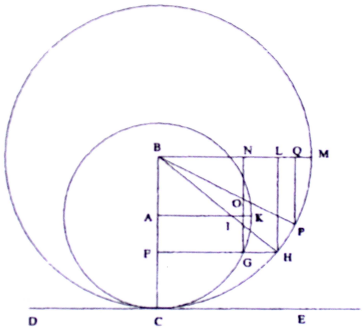

Figure VI.18: The figure of page 60.

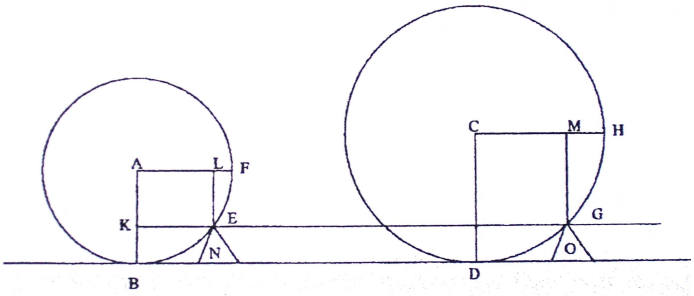

Figure VI.19: The figure of page 61.

In effect, the contact points E, G of the obstacles and the circles could be considered as the fulcra. According to Pappus's treatment of the inclined plane,[2] the respective levers are ALF and CMH – the forces are supposed to act in F and H and the weights of the circles can be thought to be concentrated in their

[1]Note that also the *Quaestiones Mechanicae* approach the problem of the movement of a spherical or cylindrical bodies (*Quaestio* VIII). Yet, it obviously does not treat the case of obstacles dealt with, in contrast, by Guidobaldo on the pages in question.

[2]Certainly, the problem in question concerns bodies on the horizontal and not on an inclined plane. Yet, for its analogy Pappus's treatment can be modified to the present problem: instead of the contact point between inclined plane and body, here the contact point of the obstacle and the circle constitutes the fulcrum of an imagined lever.

centres.[1] In a lengthy and accurate geometrical demonstration (cf. figure VI.18), Guidobaldo proves that $AL : LF > CM : MH$.[2] Therefore, the *potentia sustinens* holding the *scytala* in H is smaller than the one in F which produces the same effect.[3] Consequently, also the *potentia movens*, acting in H and required to move the cylindrical body DGH, is smaller than the one acting in F necessary to roll the *scytala* BEF.

VI.2.3 Practical questions

There are some entries in the *Meditatiunculae* in which Guidobaldo approaches topics relative to the targeting with a cannon, to practical (dis-)advantages of certain kinds of mechanical machines, to the inclination of roofs, or of the water intake of a mill. On the basis of what we have exposed about his practical activities,[4] they seem to be reflections, to a certain degree also theoretical elaborations of Guidobaldo's everyday-experiences as architect and inventor of scientific instruments or of his activities connected to military engineering. Interestingly, the great part of the pages in question is written in Italian, not in Latin: an additional confirm of the entries' close relation to praxis.

Targeting with a cannon

On pages 39/40, Guidobaldo treats how to target with a cannon against a certain point on a wall. Interestingly, he supposes the cannonball to follow a straight line as trajectory. But more than in the actual trajectory, though, Guidobaldo here is interested in a practical problem: if the cannon is not of high quality, and despite of targeting at a point e the cannonball ends in the point f (cf. figure VI.20), which measures have to be taken to correct this mis-shot?

[1] Interestingly, on page 64 Guidobaldo treats exactly the problem of the inclined plane, essentially according to Pappus's approach. Therefore, the problem treated of pages 60/61 plausibly stimulated Guidobaldo to return to reflect on the problem of the inclined plane. Equally interesting for the heterogeneous character of the *Meditatiunculae* is the fact, that these two thematically connected treatments are divided by a complete different problem on pages 62-63, dealing with a geometrical problem, going back to Pappus.

[2] In effect, Guidobaldo draws the line FGH parallel to horizon, where G later is identified with the contact point with the obstacle for the smaller circle, and H for the bigger one. Then, from G, H two perpendiculars are drawn that intersect the horizontal lines AK, BM (drawn from the respective centres of the circles) in the points I, L. These points constitute the fulcra (or more precisely, the vertical projections of the fulcrums) of the respective levers AIK and BNM. The demonstration consists in showing that $AI : IK > BL : LM$. This corresponds, with the notations of figure VI.19 (i.e. of Guidobaldo's treatment on page 61, to the inequality $AL : LF > CM : MH$.

[3] Note that both cylinders were supposed to have the same gravity.

[4] Cf. Part A, IV.1.

Guidobaldo's suggested solution testifies the close relation to praxis of this problem: a straw (!) would have to be applied at the aperture of the cannon and brought to such a position that its upper point g lies on the line between the point a of the eye and the impact point f. So, the point g would serve as the adjustment point, as the shot from a over g ends up in f – the trajectory was supposed to be a straight line. Now, if the cannon was moved in a position that g lies on the line between a and the initial aiming point e, the second shot will hit e.

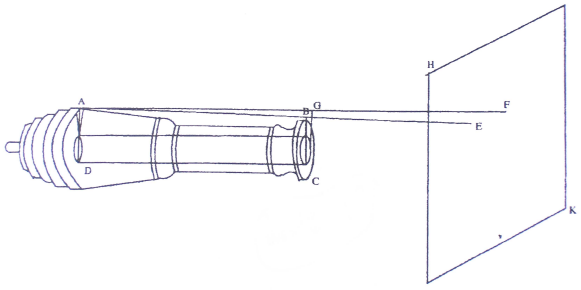

Figure VI.20: Adjusting a badly targeting cannon: page 39 of the *Meditatiunculae*.

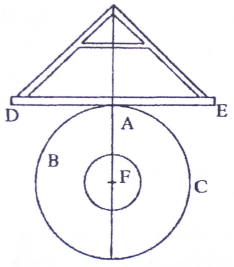

Figure VI.21: The aperture of the cannon in cross section, and an instrument with a plumbline.

Conclusively, Guidobaldo admits that a low-quality cannon seldom succeeds in targeting the same point, even if maintained in the same position.
A final comment on page 40 explains how to determine the highest point of the cannon end and the cannon aperture – this is essential for the Guidobaldo's solution proposal of page 39. This passage has a more formal and geometrical character, as citations both of a proposition of Euclid's *Elements* and of the *Mechanicorum Liber* show.

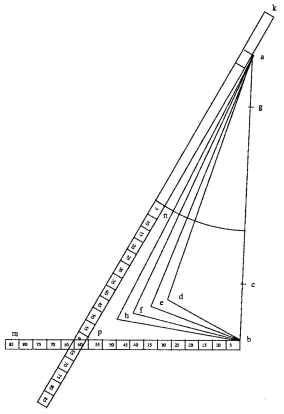

Figure VI.22: An instrument to draw hyperbolas.

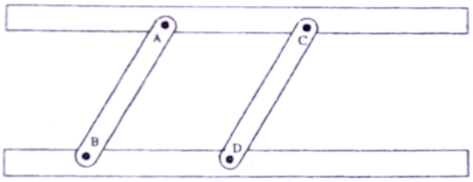

Figure VI.23: One of the two instruments for drawing parallels.

Mathematical instruments

The invention of and occupation with scientific instruments was surely no secondary aspect of Guidobaldo's scientific work.[1] This part of his interests is represented by two entry groups. On pages 7/8, Guidobaldo describes the procedures (and an instrument) how to draw a hyperbola (cf. figure VI.22), and on page 112, he exposes two instruments for drawing parallel lines (cf. figure VI.23).

Advantages and disadvantages of certain mechanical machines

In the entry which occupies pages 135 and 136, Guidobaldo discusses the advantages and disadvantages of wheels disposed vertically or horizontally. The language is Italian.
A decisive disadvantage of the vertical running wheel, operated by men walking in it, would be that the force could not ever be applied in A (cf. figure VI.24), but only in points nearer to the vertical axis, like C. If the wheel were arranged parallel to the horizon, its mover could instead apply the force in A – which would be more convenient, in the light of the law of the lever. Another advantage of the horizontal arrangement, according to Guidobaldo, is that the mover can walk on the plane, while he is constrained to continuously walk upwards in the other case. Yet another positive element would be that all around the horizontal wheels can be placed men to move them, whilst for the vertical ones the movers can be situated inside only from C to H and outside from K to I, while their the lever arm continuously changes. Further, the vertical wheels cannot be operated by horses or other animals, in contrast to the horizontal ones. Finally, the vertical wheels are more expensive as they have to be designed more stable in order to make them support the weights of men.

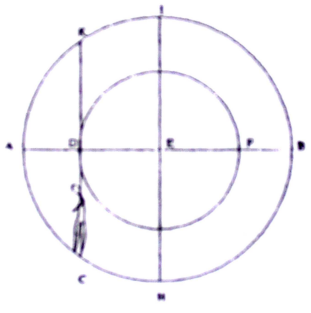

Figure VI.24: A running wheel with a men operating it in C.

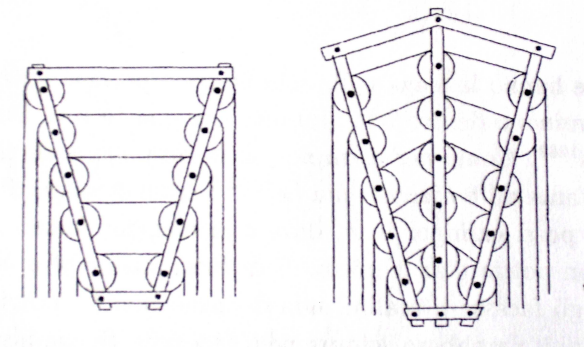

Figure VI.25: Guidobaldo's considerations how to diminish friction for systems of pulleys with many wheels and ropes.

The advantage of the horizontal wheels instead is that the working force is the

[1] For further information on this topic, cf. Part A, IV.1.1.

mover's weight, while in the horizontal case the operating men (or animals) generally can apply less force by pushing or pulling and might get tired more rapidly. Guidobaldo then comes to speak about pulleys: sometimes the pulleys in use are made of many wheels and ropes which implies the risk of friction of the respective components (cf. figure VI.25). He exposes arrangements how this can be avoided. Further, he gives suggestions for their material and dimension.

Then, on page 147, Guidobaldo argues about the advantages or disadvantages of using several interconnected machines instead of just one, bigger machine (cf. figure VI.26). The system of several smaller machines generally could be more easily adapted to circumstances with limited space, while it would present more axes and therefore more friction.

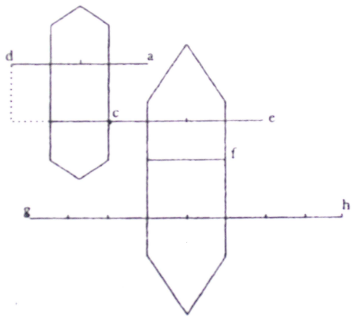

Figure VI.26: Representation of a system of interconnected machines.

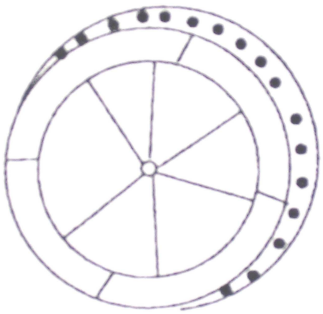

Figure VI.27: Perspective representation of a wooden support with an iron rim on page 116.

Page 116 reports a perspective representation of a wooden support with an iron rim. Guidobaldo's short comment is not indicative, however, of the actual use of this device.[1]

On the inclination of roofs and of a mill's water intake

On pages 236 and 237, Guidobaldo argues about two problems connected with inclination: first, he considers the water intake of a mill (cf. figure VI.28): he states that the channel has to be 15 (presumably feet)[2], if the height is 10. And, "for the general rule", the channel would have to be inclined at about 45 degrees, but this would have to be adapted according the actual quantity of water.

[1]Guidobaldo comments: "I <fori> scuri deveno passar dentro gli altri; vogliono esser solo nella piastra di ferro, senza passar nel legno". We would like to thank prof. Maccagni for his interpretation of this at first sight rather cryptic drawing.

[2]Guidobaldo does not specify the unity of measure. Maybe, he referred only to the ration of 15:10, i.e. 3:2, between the length of the channel and the slope.

Further, Guidobaldo drew two models of roofs on pages 236/37. He does not provide further explanations in regard, but one of them is captioned "this is the maximal and minimal inclination of the roofs in these countries". This suggests that he reflected on the different possibilities of constructing roofs and is another connection with his practical activities.

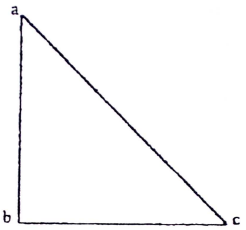

Figure VI.28: Representation of a mill's water intake.

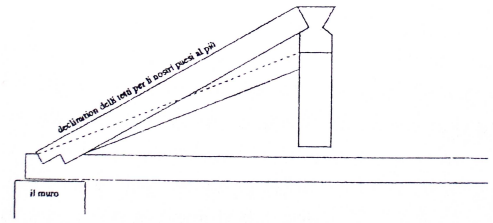

Figure VI.29: The model of a roof with different inclinations.

VI.2.4 Problems relative to natural philosophy

The *Meditatiunculae* present not also problems on balances and more or less practical observation on mechanical machines, but contains also precious information on Guidobaldo's occupation with questions connected with natural philosophy. The first entry, on pages 41-42, approaches the problem of the velocity with which bodies descend in a fluid. The second one, page 54, considers a problem relative to the movement of Earth, in form of a minuscule oscillation around the centre of the world. Page 236, the probably most famous page of the *Meditatiunculae* deals with the trajectory of projectiles.

The descent of bodies in a fluid[1]

The problem of descending bodies in a fluid was in vogue in the sixteenth century: scholars like Cardano, Moletti and Benedetti dealt with it.[2] Guidobaldo's text on pages 41-42, though, does not hint at a possible inspiration by one of these scholars' approaches to the problem. It states that bodies ("*solidae magnitudines*") of the same kind and form descend with the same velocity – independently thus from their gravity.
For the sake of a better exposition, we use the following functional notations (absent, obviously, in the text): be $M(x)$ the *magnitudo* of a body x (i.e. his

[1]We would like to thank prof. P.D. Napolitani for having us given access to an unedited paper of his, in which he analysed this interesting entry.

[2]Cf. Part A, III.5, particularly p. 102.

volume, modernly spoken), $G(x)$ its gravity, and $l(x)$ the quantity of the liquid which occupies the same volume of x (i.e. $M(x) = M(l(x))$).
Let A and B be two bodies of the same kind and form, but with different volumes, with $A > B$; let C be a quantity of fluid having the same volume as A, and D a quantity of fluid of the same volume as B. So $M(A) : M(B) = M(C) : M(D)$. As A, B on the one hand, and C, D on the other are of the same kind, we have $M(A) : M(B) = G(A) : G(B)$ and $M(C) : M(D) = G(C) : G(D)$. The combination of these three relations, $G(C) : G(A) = G(D) : G(B)$, concludes the first argumentative unit of the demonstration.

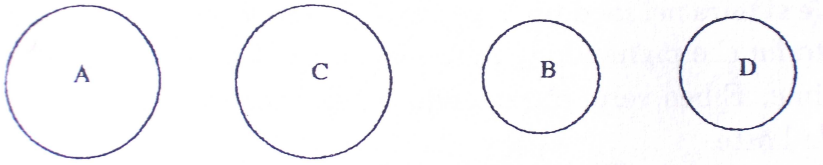

Figure VI.30: The figure of page 41 represents spherical bodies, but the text refers to general "*solidae magnitudines*".

The second unit is rather difficult to interpret: Guidobaldo introduces the notion of "*proportio resistantiae*", without specifying how he conceived this resistance and its dependencies.[1] A plausible interpretation of the text seems to be:[2] Guidobaldo seems to interpret the Archimedean buoyancy as the resistance exercised by the fluid against the motion of the body in it: this follows an Aristotelian conception of motion: gravity is the cause of *heavy body*'s *natural movement* downwards, and any effect that diminishes the gravity, like buoyancy, constitutes a factor which diminishes the motion, and consequently constitutes a resistance. So, the "resistance of the liquid to the body A" would be, in our notation, $R(A) = G(C)$, since the gravity of A in the liquid is diminished, according to the Archimedean principle, by $G(C)$. Therefore, the result of step I can be written as $R(A) : G(A) = R(B) : G(B)$. In effect, Guidobaldo states that the relation of the resistances to the bodies A and B are equal. Immediately afterwards, he concludes that therefore the descent velocities of the bodies are the same.[3]

[1]The passage in question is this – we report the final text, for the corrections and modifications cf. Tassora's transcription; cf. *Meditatiunculae*, p. 41: "Idcirco, cum sit c magnitudo humidi aequalem molem habens ipsi a, et d ipsi b, proportio, quam habet gravitas c ad gravitatem a, et gravitas d ad gravitatem b nihil aliud erit, nisi proportio resistentiae, quam facit humidum ad magnitudines a, b quae iam ostensa est aequalis. Quoniam autem solidae magnitudines humido graviores demissae in humidum, feruntur deorsum, donec descendant; et sunt in humido tanto leviores, quanto est gravitas humidi molem habentis solidae magnitudini aequalem ut demonstrat Archimedes in septima primi *De iis, quae vehuntur in aqua*."

[2]This is the plausible interpretation found by prof. P.D. Napolitani.

[3]Cf. *Meditatiunculae*, p. 42 :"Eadem igitur erit proportio resistentiae, quam habet humidum

The conception that would justify this conclusion, is that of velocity proportional to a body's weight, and inversely proportional to the resistance of the medium: i.e. the Aristotelian conception of motion. Therefore, the "*proportio resistentiae*" would be exactly the inverse of the velocity: $R(A) : G(A) = R(B) : G(B)$ would be equivalent to $1/v(A) = 1/v(B)$.
The short last two paragraphs argue that the same consequence is valid in the case, that (modernly spoken the specific weight of the bodies in question is equal or smaller than the fluid's.

If this interpretation is right, the present entry would be another manifestation of Guidobaldo's intent to conciliate Archimedean mechanics (here: the law of buoyancy) with elements of the Aristotelian natural philosophy (in this case: the dependency of the descent velocity of a body on his gravity and (inversely) on the resistance of the medium). Another similar proceeding is presented in the preface of the *Paraphrasis*, where Guidobaldo explained the properties of the concept *centre of gravity* – the fundamental concept of Archimedes's mechanics – by having recourse to central elements of the Aristotelian cosmos-conception.[1]

"*Terram moveri hoc modo ostendetur*"

Page 54 is for several reasons a remarkable entry: it testifies Guidobaldo's occupation with questions relative to cosmology and permits to have an idea about his lost treatise *De Motu Terrae*.[2] Again, it constitutes an application of "Archimedean" elements (*centre of gravity*, law of the lever) to the Aristotelian cosmological model – this entry does not refer, despite of the suggestions the title might arouse, to a question relative to Copernicanism. Guidobaldo's reasoning is the following:
Earth, represented by the spherical body $BCDE$, is supposed to be at rest, so its barycentre A necessarily coincides with the centre of the world. Now, a heavy body F (e.g. a tower) is thought to be added on the surface of Earth; be H its centre of gravity. Let A and H be connected and divided in K, with HK to KA equal to the ratio of the gravities of Earth $BCDE$ and the body F; thus, K is the barycentre of the system composed by Earth and the body H.
Now, that fact that any (in the Aristotelian sense) *heavy body* tends to the centre of the world, means that its centre of gravity tries to unify with the centre of the world.[3] Consequently, the system composed by H and Earth moves along KA until K coincides with A.
Every time when on the surface of Earth the position of any object changes –

ad magnitudinem a et ad magnitudinem b, ac propterea magnitudines a, b in humidum demissae ferentur deorsum, et eodem tempore aequale spatium pertransibunt."

[1] Cf. Part A, V.2.4.

[2] Cf. Appendix I, I.7.3.

[3] This reasoning is developed in the preface of Guidobaldo's *Paraphrasis*, cf. Part A, V.2.2.

like the construction of a "house, tower, city, or the motion of animals" – such a movement back and forth regarding the centre of the world takes place. So, Earth moves "very often, even if this movement is completely imperceptible".

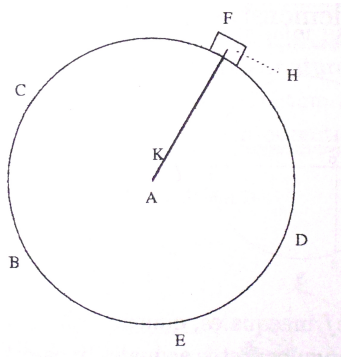

Figure VI.31: The figure of page 64.

With all probability, this reasoning was a part of Guidobaldo's lost treatise *De Motu Terrae*. And it might have been this argumentation, or a similar one, which he referred to in a letter to his philosopher-friend Federico Bonaventura: therein,[1] he exhorted Bonaventura to publish a book he was working on,[2] because Guidobaldo wanted

> to cite them, and I will do so with pleasure, particularly because I have a caprice that Earth does move and this because of Aristotle. But these are things (as You know better than me) that have to be reflected well, and I would not show them around before I will not have the consent of the first philosophers: so that they would make me become aware of my error if there were any, because I confess not to see any. And the more I reflect on it, the more I am sure about it.[3]

The meaning of the phrase "and this with the authority of Aristotle" suggests, however, that Guidobaldo explicitly referred to a certain passage of an Aristotelian work. It might have been the following one, of Aristotle's second book of *On the Heavens* (chapter 14):

[1]The respective letter is published in D. Bertoloni Meli, *Guidobaldo dal Monte and the Archimedean Revival*, cit.

[2]It is not completely clear to which work of Bonaventura referred here: possibly, the question is about the *De causa ventorum*, in the end published in 1594.

[3]Cf. Guidobaldo's letter to F. Bonaventura, December 8th 1588; Biblioteca Comunale, Forlì, Autografi Piancastelli, 755: "mi serviranno a me per citarlo et lo farò volentieri, massime che ho un capriccio che la Terra si muova, et questo in via di Aristotele. Ma sono cose che (come Lei sa meglio di me) bisogna prima pensarci bene, e non le lascierei vedere se prima io non avessi il consenso di primi filosofi, acciò mi faccino accorger del mio errore, se vi è, perché io da me stesso confesso che non me ne so accorgere. E quanto più ci penso, tanto più mi ci confermo."

> If, then, a weight many times that of the Earth were added to one hemisphere, the centre of the Earth and of the world will not longer be coincident. So that either the Earth will not stay still at the centre, or if it does, it will be at rest without having its centre at the place to which it is still its nature to move. Such is the difficulty. A short consideration will give us an easy answer, if we first give precision to our postulate that any body endowed with weight, of whatever size, moves towards the centre. Clearly it will not stop when its edge touches the centre. The greater quantity must prevail until the body's centre occupies the centre. For that is the goal of its impulse. Now it makes no difference whether we we apply this to a clod or common fragment of Earth or to the Earth as a whole. (...) Therefore Earth in motion, whether in a mass or in fragments, necessarily continues to move until it occupies the centre equally every way (...).[1]

So, even if the passage considers a weight "many times that of the Earth", the reasoning is easily generalisable to any *heavy body*: Earth's barycentre, by the addition of another weight, does not coincide any more with the centre of the world. In effect, the phrase "Therefore Earth in motion, whether in a mass or in fragments, necessarily continues to move until it occupies the centre" must have been a confirmation for Guidobaldo's reasoning on page 54 of the *Meditatiunculae*. Anyway, even if the latter at the present state does not seem to be datable with certainty, it appears very probably, that both elements (the entry in the *Meditatiunculae* and an Aristotelian passage, the aforesaid one or a similar one referred to in the letter to Bonaventura, were parts of Guidobaldo's lost *De Motu Terrae*.
Apart from the question about the possible contents of *De Motu Terrae*, the noteworthy fact is that Guidobaldo was interested in and dealt with such problems relative to cosmology and natural philosophy. It is important to keep in mind this trait of his complex scientific personality, for a better understanding of certain elements of his work.[2]

On the trajectory of a bodies

Page 236 probably is the most famous page of the *Meditatiunculae* being frequently cited by historiographers of sixteenth-century mechanics.[3] It contains

[1] Cf. Arist., *On the Heav.* 297a31 - 297 b20. We want to express our gratitude to E. Nenci who, at the seminar at Gargnano 2011, has referred to this passage in his talk.

[2] For further information on this topic, cf. Part A, chapter V, particularly V.1.1, V.1.2 and V.2.4.

[3] This page has been cited by scholars like G. Libri, R. Caverni or P.L. Rose. The most accurate study on it is J. Renn, P. Damerow, S. Rieger, and M. Camerota, *Hunting the white elephant: when and how did Galileo discover the laws of fall?*, Preprint 97, Max-Planck-Institut

the description of an experiment on the trajectory of projectiles. A spherical body is reported to be thrown on an inclined, nearly vertical plane; if it priorly is dipped in ink, the ball leaves a symmetrical trace on the inclined plane that resembles a inverted catenary or "a parabola and a hyperbola". In the following, we report the passage in question.

> Se si tira una palla, o con una balestra o con artiglieria o con la mano o con altro instrumento, sopra la linea dell'orizonte, il medesimo viaggio fa nel callar che nel montar, e la figura è quella, che rivoltata sotto la linea horizontale fa una corda, che non stia tirata, essendo l'un e l'altro composto di naturale e di violento, et è una linea in vista simile alla parabola et hyperbole <cf. figure VI.32>.
> E questo si vede meglio con una catena, che con una corda perché la corda *abc* <cf. figure VI.33> quando *ac* sono vicini la parte *b* non si accosta come doverebbe percioché la corda resta in sé dura. Che non fa così una catena o catenina.
> La esperienza di questo moto si pò far pigliando una palla tinta d'inchiostro, e tinta d'inchiostro, e tirandola sopra un piano di una tavola, il qual stia quasi perpendicolare all'orizonte, che se ben la palla va saltando, va però facendo li punti, dalli quali si vede chiaro, che sicome ella scende, così anco descende; et è così ragionevole, perché la violentia che ella ha acquistata nell'andar in su, fa che nel callar vadi medesimamente superando il moto naturale nel venire in giù. Che la violentia che superò da *b* al *c* conservandosi fa che dal *c* al *d* sia eguale a *cb* <cf. figure VI.34>, e descendendno di mano in mano perdendosi la violentia fa che dal *d* al *e* sia eguale a *ba*. Essendo che non vi è ragione, che dal *c* verso *de* mostri, che si perda a fatto la violentia che se ben va continuamente perdendo verso *e*, nondimeno sempre se ne resta, che è causa, che verso *e* il peso non va mai per linea retta.

Figure VI.32: The representation of a trajectory.

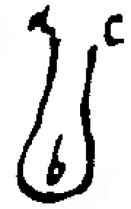

Figure VI.33: The representation of a chain.

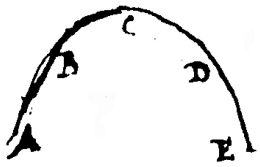

Figure VI.34: Another representation of a trajectory.

für Wissenschaftsgeschichte, 1998.

VI.2.5 *Centrobarica*

Page 116 of the *Meditatiunculae* contains, after a short comment on a mechanical machine, a proposition on the properties of the *centre of gravity*. It states that a plane figure, intersected by a line passing through its barycentre, is not necessarily divided in two parts of equal area. This is the same proposition as the one Guidobaldo had inserted at the end of the first book of his *Paraphrasis*. Let us compare the respective argumentations:

Meditatiunculae, p. 116

Figura per centrum gravitatis in duas partes secta non semper in partes dividitur aequales.
Sit triangulum aequilaterum *abc* cuius centrum gravitatis *d*, a quo ipsi *bc* aequidistans ducatur fdg. Dico partem afg minorem esse parte $bfgc$.

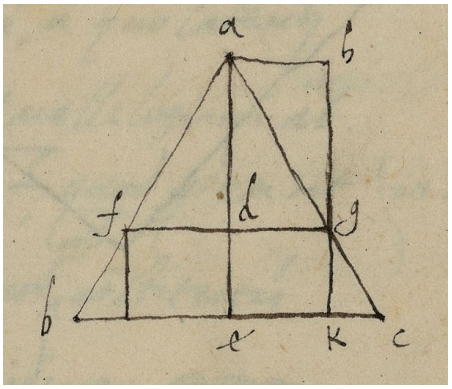

Figure VI.35: The figure of page 116 of the *Meditatiunculae*.

Ducatur per *da* usque ad basim linea *ade*, cui per *g* aequidistans ducatur *hgk*, compleanturque figurae *eh*, kf.

Paraphrasis, p. 114

Figura dari potest, quae per centrum gravitatis recta linea divisa, non semper in partes dividatur aequales.
Habeat triangulum ABC latera AB, AC aequalia. Trianguli vero centrum gravitatis sit D, a quo ipsi BC aequidistans ducatur FDG. Dico partem AFG minorem esse parte $BFGC$.

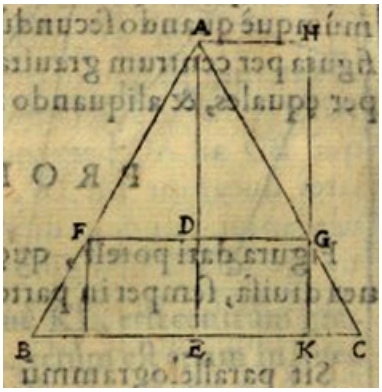

Figure VI.36: The figure of page 114 of the *Paraphrasis*.

Ducatur ADE, quae bifariam BC dividet, et a puncto G ipsi AE aequidistans ducatur HGK, compleanturque figurae EH, KF. Quoniam enim FG aequidistans est ipsi BC, erit FD ad DG, ut BE ad EC, et est BE ipsi EC aequalis. Erit igitur FD ipsi DG aequalis, ut etiam paulo an-

Quoniam igitur d centrum est gravitatis trianguli abc, erit ad dupla ipsius de, ergo parallelogrammum ag duplum est parallelogrammi ge. Et quia gd, df sunt aequales, erit quoque kf ipsius kd duplum.
Ergo ag, hoc est afg, ipsi fk est aequale, quare afg minor est quam $bfgc$, quod demonstrare oportebat. Hoc idem sequitur in triangulo aequicrure.

te 15. <propositionem> huius <libri> ostendimus. Quare FG ipsius DG dupla est, ac propterea parallelogrammum FK duplum est parallelogrammi DK.
Quia vero AD ipsius DE dupla existit, erit quoque parallelogrammum DH ipsius DK duplum. Quare DH ipsi FK est aequale.
At vero quoniam FG dupla est ipsius DG, erit triangulum AFG parallelogrammo DH aequale. Triangulum igitur AFG parallelogrammo FK est aequale. Quare pars AFG parte $LFGC$ minor existit, quod demonstrare oportebat.
Hinc perspiccum est eandem figuram per centrum gravitatis divisam, aliquando in partes inaequales, aliquando in partes aequales dividi posse. In partes inaequales iam ostensum est hoc accidere per lineam FG. In partes vero aequales patet per lineam ADE, quae triangulum ABC in duo aequa dividit. Triangulum enim ABE triangulo AEC est aequale, cum sind sub eadem altitudine, basesque BE, EC interse sint aequales.

So, both versions present the same key idea by showing that the parallelograms FK and AG are equal: then, as the little triangle AFG is equal to AG, but the trapezium $BCGF$ bigger than FK, the big triangle ABC is divided in two unequal parts AFG and $BCGF$. The respective argumentations are evidently differently elaborated. Both, however, use the fact that the triangle's barycentre divides its meridian in the ratio 1:2. The only substantial divergence is the presence of a conclusive comment of the *Paraphrasis*-version that revisits the statement of the *protasis*: the isosceles triangle is an example of a figure that can be, but has not necessarily to be divided in two equal parts. The division by the meridian yields two equal figures, the division by the line FDG parts of different area.
So, on the argumentative level both demonstrations are nearly identical. The existing differences, that mainly regard the grade of detailedness and elaboration, seem to be owed to the higher formal exigencies of the *Paraphrasis*-version as

part of a published book. Therefore, it seems reasonable to consider the *Meditatiunculae*-entry as draft of the other version, containing already the key idea and the essential geometrical reasoning.

Interestingly, the *Meditatiunculae*-entry is not only connected with the *Paraphrasis*, but shows a most notable similarity to the problem that Guidobaldo's disciple Francesco Guerrini posed to Clavius after the former's death which we have exposed above.[1] This fact, coupled with other information about Guidobaldo's activity as instructor of future engineers and architects, hints at the possible origin of this problem: it seems to have been one of the basic problems of the barycentre-theory he taught to his disciples – in fact, the nucleus of the problem is related to the concept of *moment*: the centre of gravity does not divide a figure in parts of equal weight (or area, in the geometric example), but of equal moment – and considered it as so instructive to include it in the *Paraphrasis*: note that this book was precisely addressed to "beginners" of mechanical studies so that Guidobaldo's teaching experiences may have formed a guideline for the possible inclusion of basic problems.

VI.2.6 Two different approaches to the inclined plane

The *Meditatiunculae* contain two substantially different approaches to the problem of the inclined plane. The first, on page 64, exposes essentially the (erroneous) Pappian solution, while the second, on page "145bis", shows remarkable similarities with the solution, that is presented also in the Galilean *Le Mecaniche*.

The approach of page 64

Guidobaldo, after the publication of the *Mechanicorum Liber*,[2] which referred to the solution of the inclined plane-problem exposed in the eighth book of Pappus's *Collectiones Mathematicae*, revisited the topic, which force would be requested to hold a spherical body on an inclined plane. His approach on page 64 of the *Meditatiunculae* accepts the fundamental Pappian conception to reduce the problem to the one of the lever, situated in the horizontal plane passing through the point g where force acts (cf. figure VI.37). The intersection h of the plane with the vertical line above the contact point c of the maximal circle of the sphere and the inclined plane furnishes the fulcrum h of the lever. The weight of the sphere, which has to be sustained, is thought to be concentrated in the point k, vertically above (or below) the centre of (gravity of) the sphere.
Guidobaldo first distinguishes three cases (cf. figure VI.37), according to the three kinds of lever – both in *Le Mechaniche* (1581) and in the *Collectiones*

[1] Cf. part A, IV.1.2.

[2] In effect, the text cites the chapter *De Vecte* of the *Mechanicorum Liber*, whose publication year 1577 thus constitutes a *terminus a quo* for this page.

Mathematicae (1588) only the first situation was considered. The force required to hold the spherical body can easily be calculated with recourse to the law of the lever.

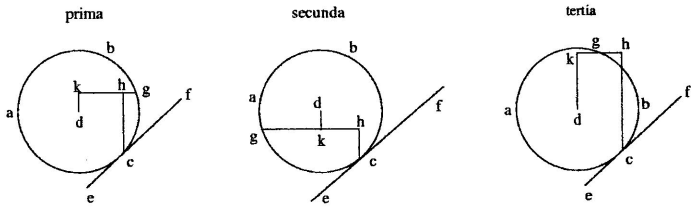

Figure VI.37: The figure on page 64 of the *Meditatiunculae*.

Then, apparently in a second moment, he added a paragraph on another case, namely the one in which the sphere is sustained vertically above or below the barycentre of the sphere: then, the force required the sphere corresponds to its whole weight.

Page "145bis"

A different approach to the same problem of the inclined plane can be found on page "145bis". Since it contains interesting similarities to the Galilean solution of *Le Mechaniche*, we will expose it, subsequent to the *Meditatiunculae*-version. The latter can be subdivided in three steps: the first two regard the angular balance and its effective lever arm, while the third then approaches the real problem of the inclined plane.

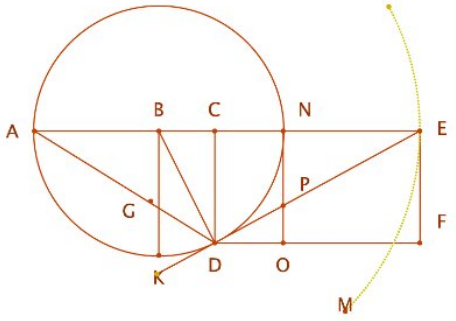

Figure VI.38: The figure of the Guidobaldo's second approach to the inclined plane on p. 145bis. The dashed line is scratched out in the original.

The first step consists in considering the angular balance ABD (cf. figure VI.38). Guidobaldo supposes two weights a, d in A, D in the state of equilibrium. Therefore, as the balance is sustained in its centre B, the centre of gravity of the system must lie vertically below B, and on the other hand on the line AD, therefore in the

intersection G.[1] So, for the law of the lever $d : a = GA : DG$. Now, if CD is drawn vertically, from the theorem of intersecting lines follows $AG : DG = AB : BC$; so combining with the precedent proportion: $d : a = AB : BC$, i.e. the weight in D has the same effect if it were applied to a straight balance on a lever arm BC.

In the second step, which presents many cancellations, corrections and additions, Guidobaldo imagines two equal weights in A and D, and asks in which relation they are. This passage is very informative about Guidobaldo's conception of the *proto-moment* – in fact, for sake of a better understanding, it is advisable to adopt the notation $gr_X(y)$, in order to indicate the *effective gravity* (i.e. the *proto-moment*) of a weight y in the point X.[2]
The results of the first step can be written as $d : a = AG : DG$ and $gr_D(d) = gr_A(a)$ – in effect, d in D was supposed to be in equilibrium with a in A, i.e. they have the same *effective gravity* (i.e. *proto-moment*). Now, imagine a weight l equal to d and placed in A. For $d = l$, we have $l : a = AG : DG$; further – this key element remains implicit – $gr_A(l) = gr_A(a) = l : a$, since the *effective gravity* of two bodies in the same point is proportional to their gravities. So, we have

$$gr_A(l) = gr_A(a) = l : a = AG : DG.$$

With $gr_D(d) = gr_A(a)$, this means

$$gr_A(l) : gr_D(d) = AG : DG = AB : BC, \ q.e.d.$$

The third step then approaches the actual problem: be *dpe* an inclined plane, with horizontal component *df* and vertical component ef, which is tangent in d to the circle (described by the balance arm AB).[3] The hypothesis is: the *potentia sustinens* required to hold a weight along the vertical ef is to the *potentia sustinens* required to hold it along the inclined plane *de* like $de : ef$, which corresponds to the correct statement of the law of the inclined plane. Let us have a look at the demonstration:
Be n a weight equal to d in N: its effect along *no* is like if it were fixed on a balance arm BN, as the angle BNO is right. Analogously, the weight d on the angular balance arm BD has the same effect as if it were along the inclined plane

[1] Guidobaldo uses here two facts: on the one hand, the first proposition *De Libra* of the *Mechanicorum Liber*: a body is in rest if and only if the line from its suspension point to its barycentre is perpendicular to horizon; on the other hand, the fourth proposition of Archimedes's *Equilibrium of Planes*: its demonstration states that the centre of gravity of two figures (weights) lies on the connection line of their barycentres.

[2] In effect, Guidobaldo's terminology in the second step is changed compared to the first one: now, he speaks of "*eadem gravitas*" of two different weights: he obviously refers to the *effective gravity* (i.e. the *proto-moment*) of these different weights. For further information about Guidobaldo's conception of the *proto-moment*, cf. Part B, II.4.

[3] Guidobaldo uses this fact, but does not explicitly state that the inclined plane is the tangent in d.

de, since the angle BDE is similarly right. Now, with $gr_N(n) = gr_A(n) = gr_A(l)$ ($n = d = l$ and equal balance arms!), the result of step II implies $gr_N(n) : gr_D(d) = AB : BC = BD : BC$.
This means that the *potentia sustinens*, holding the weight n (with $n = d$) along *no*, is to the *potentia sustinens* which keeps at rest the weight d along the inclined plane *dpe*, *q.e.d.*

Let us compare Guidobaldo's version of the *Meditatiunculae* with Galileo's exposed in *Le Mecaniche*:[1]

> Intendasi dunque il cerchi AIC, ed in esso il diametro ABC, ed il centro B, e due pesi di eguali momenti nelle estremità A, C; sì che, essendo la lineo AC un vette o libra mobile intorno al centro B, il peso C verrà sostenuto dal peso A.Ma se c'immagineremo il braccio della libra BC essere inclinato a basso secondo la linea BF, in guisa tale però che le due linee AB, BF restino salde insieme e continuate nel punto B, allora il momento del peso C non sarà più eguale al momento del peso A, per esser diminuita la distanza del punto F dalla linea della direzione che dal sostegno B, secondo la BI, va al centro della terra. Ma se tireremo dal punto F una perpendicolare alla BC, quale è la FK, il momento del peso in F sarà come se pendesse dalla linea KB; e quanto la distanza KB è diminuita dalla distanza BA, tanto il momento del peso F è scemato dal momento del peso A. E così parimente, inclinando più il peso, come saria secondo la linea BL, il suo momento verrà scemando, e sarà come se pendesse dalla distanza BM, secondo la linea ML. (...)
> Vedesi dunque come, nell'inclinare a basso per la circonferenza $CFLI$ il peso posto nell'estremità della linea BC, viene a scemare il suo momento ed impeto d'andare a basso di mano in mano più, per esser sostenuto più e più dalle linee BF, BL. Ma il considerare questo grave discendente, e sostenuto dalli semidiametri BF, BL ora più e ora meno, e costretto a caminare per al circonferenza CFL, non è diverso da quello che saria imaginarsi la medesima circonferenza $CFLI$ esser una superficie così piegata, e sotto posta al medesimo mobile, sì che, appoggiandovisi egli sopra, fosse costretto a descendere in essa; perché se nell'uno e nell'altro modo disegna il mobile il medesimo viaggio, niente importa se egli sia sospeso dal centro B e sostenuto dal semidiametro del cerchio, o pure se, levato tale sostegno, s'appoggi e camini su la circonferenza $CFLI$. Onde indubitatamente potremo affermare che, venendo a basso il grave dal punto C per la circonferenza $CFLI$, nel primo punto C il suo momento di discendere sia totale ed

[1]We refer here to the critical edition of R. Gatto, Firenze, Olschki, 2002. The reported passage goes from lines 940-1017.

integro, perché non viene in parte alcuna sostenuto dalla circonferenza (...). Ma se il mobile sarà constituito nel punto F, allora dall circolare via, che gli è sottoposta, viene in parte la gravità sua sotenuta, ed il suo momento d'andare al basso diminuito con quella proporzione, con la quale la linea BK è superata dalla BC: ma quando il mobile è in F, nel primo punto di tale suo moto è come se fusse nel piano elevato secondo la contingente linea GFH, perciò che l'inclinazione della circonferenza nel punto F non differisce dall'inclinazione della contingente FG, altro che del'angolo insensibile del contatto. (...)
Se dunque sopra il piano HG il momento del mobile si diminuisce dal suo totale impeto, quale ha nella perpendicolare DCE, secondo la proporzione della linea KB alla linea BC o BF, essendo, per la similitudine dei triangoli KBF, KFH, la medesima proporzione tra le linee KF, FH che tra le dette KB, BF, concluderemo, il momento integro ed assoluto che ha il mobile nella perpendicolare all'orizonte, a quello che ha soprail piano inclinato HF, avere la medesima proporzione che la linea HF alla linea FK, cioè che la lunghezza del piano inclinato alla perpendicolare che da esso ccascherà sopra l'orizonte. (...)
E se così è, resta manifesto che, sì come la forza che sostiene il peso nella perpendicolare FK deve essere ad esso eguale, così per sostenerlo nel piano inclinato FH basterà che sia tanto minore quanto essa perpendicolare FK manca dalla linea FH.

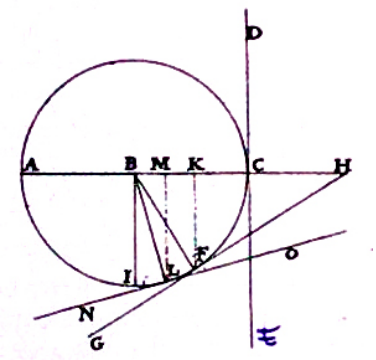

Figure VI.39: The figure accompanying Galileo's reasoning on the inclined-plane problem.

So, the key idea of both versions is identical: to reduce the problem of the inclined plane to the one of the angular balance. Also their proceeding is essentially the same, with the distinction of three steps: first, the effective gravity of a weight on an angular balance gets determined; then, the various inclinations of the angular balance are related to different inclined planes (the plane as tangent in the point where the inclined balance arm touches the circumference); and finally,

the combination of these both elements in a mathematical relation.
The similarities of these two versions are striking. It would be hardly imaginable that they were elaborated independently, without any form of exchange between Guidobaldo and Galileo. In this light, they belong to the "Galilean pages" of the *Meditatiunculae*, pages ca. 232-237, which present notable congruences with topics approached also by the Tuscan mathematician – note, that page "145bis" has been inserted after the composition of pages 145 and 146. It is thus another element of the collaboration of Guidobaldo and Galileo, about which in-depth studies would be a *desideratum*.

VI.2.7 Drafts of theorems of the *Cochlea* and practical reflections

The *Meditatiunculae* also show traces of Guidobaldo's preparatory studies on the *Cochlea*: the pages 57, 57bis, 58 and 134 expose the works on elements of the treatise that remained unpublished during his lifetime, having been posthumously published only in 1615.[1] Page 57bis deals with the fundamental problem of the cochlea, namely about its inclination that enables water to flow in it. Page 57 prepares its treatment, stating how to determine the inclination of the helices in respect to horizon. Finally, page 58 approaches the inverted problem of page 57bis: given the inclination angle of the cochlea, in which inclination have to be applied the helices to its cylinder?
Page 134 does not present a mathematical problem, but deals with a practical problem: how can a cochlea in a river be used without men's working power? Guidobaldo's solution provides a paddle-wheel connected to the cochlea and immersed in the river. The paddles would have to be arranged perpendicular to the flow direction of the river. In this way, the water propels the paddle-wheel and with it the cochlea.
Interestingly, page 134 is written in Italian, which, also in other pages, is usually associated to Guidobaldo's treatment of practical problems. On the contrary, the group of pages 57, 57bis, 58 is written in Latin and shows the attempts of a mathematical formalisation with citations of other mathematical works (*Elements*, *Mechanicorum Liber*, Vitruvius) and with the use of the Theory of Proportions. Their content corresponds to the beginning of the *Cochlea*: Proposition I goes back to Guidobaldo's reflections of page 57, page 57bis (which has been stuck in between pages 57 and 58) is identical with Proposition II, with exception of orthographical variants. Finally, page 58 presents strong similarities with Proposition IV.
A relevant aspect for the dating of the *Meditatiunculae* is the fact, that the pages 57, 57bis, 58 present corrections, cancellations and additions of a later time, deducible from the different kind of ink used.

[1] For further information, cf. Part A, I.3.

Part B

Key aspects of Guidobaldo's mechanics

Chapter I

The indifferent equilibrium: crucial element of Guidobaldo's mechanics[1]

> *This author is the first to have considered the balance in detail, and to have understood its true nature and being. (...) When the balance is sustained at its barycentre, it remains at rest wherever it is left. This last effect in particular has never been treated, nor noticed, nor manifested by anybody besides this author: on the contrary, it has been regarded as wrong and impossible by all our predecessors (...).*
>
> Guidobaldo about Guidobaldo himself in *Le Mechaniche*, fol. 28v.

The indifferent equilibrium for the isostatic balance was an "unheard" novelty presented by Guidobaldo in the Mechanicorum Liber, *in the context of a vehement discussion about the correct treatment of the balance in Renaissance mechanics. The Marchigian mathematician contested the approaches of mechanical authorities like Jordanus, Tartaglia, Cardano and Benedetti. His theory triggered a large debate in the centres of mechanical studies, meeting mainly scepticism. Guidobaldo tried to overcome this refusal both with the edition of other writings in regard, as well as with the dispatch of real exemplars of the isostatic balance confirming his theory. The indifferent equilibrium had profound consequences for Guidobaldo's ulterior scientific activity, and the very foundations of his mechanics: it can be regarded as a crucial element of his whole mechanical theory.*

[1] Guidobaldo does not use this (modern) terminology, when he refers to his theory in his writings. He calls it instead "the new opinion", emphasising its conceptual novelty. Recent studies which stress the importance of this topic are (contained in): D. Bertoloni Meli, *Thinking with objects*, cit. E. Gamba, V. Montebelli, *Le Scienze a Urbino nel tardo Rinascimento*, cit. M. van Dyck, *Gravitating towards stability: Guidobaldo's Archimedean-Aristotelian synthesis*, in "History of Science", XLIV (2006), pp. 373-407. The present analysis starts from these contributions and intends to extend their scope: it refers not only to the presentation of the topic in the *Mechanicorum Liber*, and takes into consideration particularly Guidobaldo's correspondence, illustrating the subsequent debate provoked by his "discovery" in various centres of mechanical studies and indicating its consequences for his mechanical work.

I.1 Guidobaldo's "revolutionary" theory

The context

In the first four propositions of the *Mechanicorum Liber*, in the chapter *De Libra*, Guidobaldo analyses the behaviour of several types of balances: in Proposition I, which serves as auxiliary theorem, he states that a weight, with its centre of gravity situated on the balance arm, is at rest if and only if the beam is perpendicular to the horizon. With this theorem, he goes on to prove the next two propositions which both consider equal weights attached at equal distances on a balance. The difference is, though, that the rotation point of the balance is once located *above* the balance (Proposition II, cf. figure I.1) and then *below* it (Proposition III, cf. figure I.2).

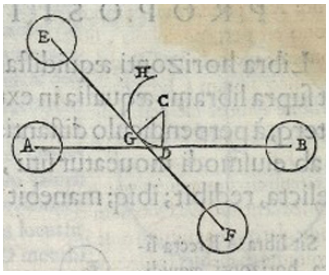

Figure I.1: The balance of stable equilibrium in Proposition II of *De Libra*. The balance rotates around point C which is, by AD, firmly connected with the beam of the balance ADB. If it is moved in an inclined position EGF it turns back to the horizontal position, i.e. until CG coincides with AD.

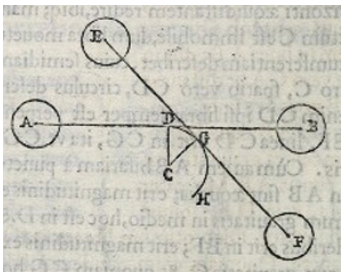

Figure I.2: The balance of unstable equilibrium in the third proposition of *De Libra*. The balance, again, can only rotate only around C which is connected trough AD with the beam of the balance ADB. If it is brought the position EGF it moves downwards (until CG will be vertical).

These two kinds of balances react differently when they are brought in an inclined position: in the first case (rotation point *above* the beam), the balance will turn to the horizontal position (Proposition II). In the second case, however, the balance moves away from the horizontal position.
In both cases, the horizontal obviously constitutes a position of equilibrium, given the equality both of the weights as of their distances from the point connected with the rotation centre C. Yet, once removed from it, the balances behave in completely different ways, as in the first case the mechanical system turns to the initial state (i.e. to the equilibrium position), while in the second it moves away from it.
Since analogous phenomena occur in physics frequently, there have been created notions to characterize these respective types of behaviour regarding displace-

ments of physical systems from equilibrium states: namely *stable* and *unstable equilibrium*, where "stable" indicates that the system recovers the state of equilibrium after an (infinitesimal) disturbance (in the case of the balance its removal from the horizontal position), while "unstable" indicates that even a minimal mutation of the initial circumstances of equilibrium suffices to remove the system from the state of equilibrium without the possibility to return to it if not by external intervention.[1]

The isostatic balance

Yet, what about the third case when the balance, after having been removed from the horizontal position, neither turns back to it, nor moves away from it; i.e. when it maintains the position in which it was brought by the intervention? This kind of equilibrium is called *indifferent*.
And in fact, there is a type of balance for which this phenomenon occurs, called *isostatic balance*. Its decisive characteristic is that the rotation point lies on the beam itself (cf. figure I.3). It is clear that, if such a balance is sustained in its rotation centre C, there is no reason that any side has to decline or to ascend.[2]

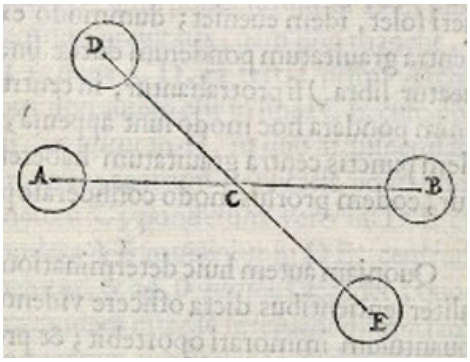

Figure I.3: The isostatic balance with indifferent equilibrium in the fourth proposition of the *Mechanicorum Liber*.

This fact might seem rather obvious nowadays - in this case the balance-system is sustained in its centre of gravity, since C is the middle point of the line that connects two equal weights. So why should it move?
Yet, in the sixteenth century, the question was in no way evident. In fact, Guidobaldo is the first[3] to have emphasised the existence of indifferent equi-

[1] Obviously, in modern physics, the displacements from the equilibrium states are considered to be infinitesimal. The gradient of the potential (i.e. the resulting force) for the equilibrium position shows then the kind of equilibrium.

[2] This can be motivated, for example, with a symmetry-argument.

[3] To be precise, Guidobaldo is the first to have published a treatise about the existence of the indifferent equilibrium. As far as precedent scholars of mechanics are concerned, it can

librium for the isostatic balance - it is the topic of Proposition IV of *De Libra* - and to have treated the different types of balances systematically.

I.1.1 The theories of balance in other authors[1]

Now, Guidobaldo was not the first who considered different types of balances or equilibria - by far not: already Aristotle's *Quaestiones Mechanicae* deal with the subject. Archimedes, too, must have treated this topic, even if the respective writing is lost.[2] In the Middle Ages, Jordanus occupied himself with this problem, then in the Renaissance his theories were re-exposed by Tartaglia and partly modified by Cardano; Benedetti developed yet another approach.
In the sixteenth century, the debate on different balances and kinds of equilibria had assumed a dynamic that nowadays might not be expected: Tartaglia was siding with Jordanus ignoring Archimedes's mechanical principles, Cardano criticised Jordanus and referred to Aristotle, Guidobaldo attacked Jordanus, Tartaglia, Cardano and combined Archimedean and Aristotelian elements in his treatment, Benedetti finally passed over Guidobaldo and disagreed, on his part, with Tartaglia, Jordanus and Aristotle. This vehement discussion permits to perceive the importance attributed to the topic - even if nowadays it could seem a minor problem of mechanics, it constituted a fundamental element in the dialogue, often controversy, between the different and diverging mechanical traditions of sixteenth-century mechanics.[3]

Aristotle

Quaestio II of the *Quaestiones Mechanicae* asks, referring to material balances: "If the cord supporting a balance is fixed from above, when after the beam has inclined the weight is removed, the balance returns to its original position. If, however, it is supported from below, then it does not return to its original position. Why is this?"[4]

---

be supposed that also Archimedes knew about its existence, cf. the last paragraph of Part B, subsection I.1.2. Also Leonardo da Vinci was aware of the existence of the indifferent equilibrium, as fol. 79r of his codex G documents - this fact is indicated (with the wrong folio) by R. Caverni, *Storia del Metodo Sperimentale in Italia*, cit., vol. IV, p. 195. The manuscripts of Leonardo are accessible online at www.leonardodigitale.com, by the kind support of the Biblioteca Leonardiana, to whose director Romano Nanni we want to express our gratitude.

[1]The following paragraph is not intended to present a complete overview of all writings on the topic in question. Relevant, for our purpose, is to hint at the context in which Guidobaldo's work is to be inserted and at the treatments with which he was confronted.

[2]In fact, Pappus mentions in the eighth book of the *Collectiones Mathematicae* a writing Περὶ ζυγῶν, i.e. *On the balance*, composed by Archimedes, cf. A. G. Drachmann, in *Fragments from Archimedes in Heron's mechanics*, cit., and F. Krafft, in *Dynamische und statische Betrachtungsweise in der antiken Mechanik*, cit. Further, Archimedes seems to have been aware of the existence of the indifferent equilibrium, cf. the last paragraph of Part B, I.1.2.

[3]A short overview of these mechanical traditions is exposed in Part A, chapter III.

[4]Cf. W.S. Hett, *Aristotle in twenty-three volumes. XIV: Minor works*, cit.

As motivation, Aristotle adduces the fact that the prolongation of the cord ΔM divides the material beam in two unequal parts, the upper one being heavier than the lower (cf. figure I.4). In the case of the support being below the beam (cf. figure I.5), the heavier part, in contrast, is the lower one: "now when the weight is removed the beam must keep its new position; for the excess over half the beam beyond K acts as a weight and depresses the beam."
So in the first case, the Stagirite rightly attributes stable equilibrium to the balance in question, whereas he seems to (wrongly) predict indifferent equilibrium to an "unstable" balance - the passage in question is not wholly clear.[1] Aristotle does not treat the isostatic balance, yet for our purpose it is important that already in antiquity it was known, that different balances behave differently.

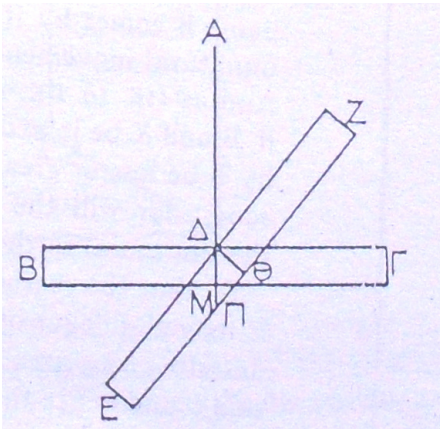

Figure I.4: The material balance with support above the beam in Aristotle's *Quaestiones Mechanicorum*.

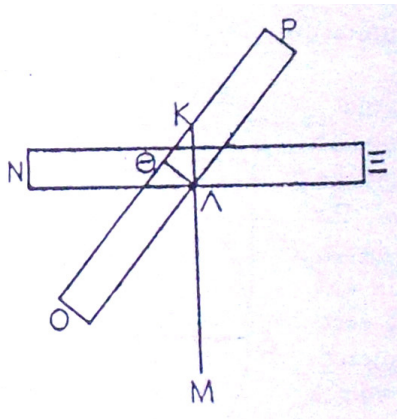

Figure I.5: The material balance supported below. Aristotle seems to predict an erroneous behaviour in this case.

Jordanus

Also in the Middle Ages, the topic was treated: all three writings *Elementa*, *De Ponderibus* and *De Ratione Ponderis*, attributed to Jordanus, deal with the isostatic balance (cf. figure I.6) - claiming the manifesting equilibrium to be *stable*.[2] The reasoning is the following:
The isostatic balance is imagined in the inclined position DE (cf. figure I.6) - with equal weights in equal distances. DA and EV are the hypothetical descents

[1] Yet, we should keep in mind that the interpretation of the sense of this question is not so easy. For example, Aristotle does not seem to really consider a balance, but rather a material beam.

[2] The isostatic balance is not the only kind of balance treated in Jordanus: the writings expose also theorems on the angular balance; the *De Ponderibus* and *De Ratione Ponderis* moreover contain some results on material balances, cf. Part A, chapter III.

of the weights along arbitrary, *equal* arcs.[1] Now, drawn the horizontal lines DO, ET and VH to the axis FG, the vertical component OC of the upper weight's descent of the weight along DA is bigger than TH, which, on its part, is the vertical component of the descent of the other weight along EV. This means, according to Axiom V, that the descent of the weight along EV is more oblique than the one of the other along DA. So the higher situated weight is proven to be positionally heavier than the lower one, whence the beam sinks down at the upper side until the balance reaches the horizontal position.
So, Jordanus' theory (erroneously) states that the isostatic balance, with equal weights in equal distances, turns to the horizontal position after having been brought to an inclined one.[2]

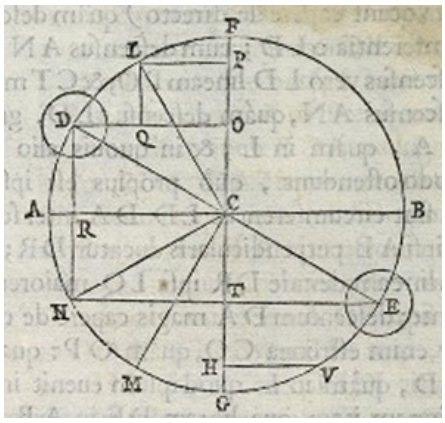

Figure I.6: The figure illustrating the second theorem of the *Elementa*.

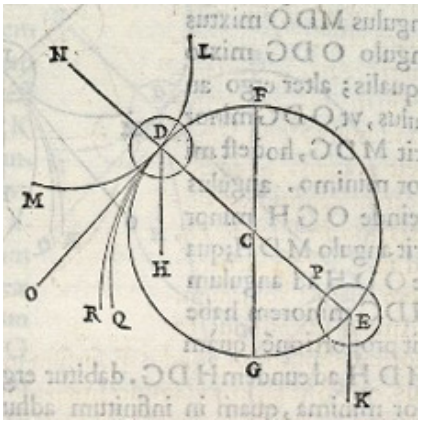

Figure I.7: Tartaglia's counter to Mendoza's objection in Prop. VI of *Quesiti et Inventioni diverse*.

Tartaglia

Jordanus's mechanical theory had a remarkable fortune, also in the sixteenth century: this is not at least Tartaglia's merit, since he exposed central elements of the medieval mathematician's mechanics in the eighth book of the *Quesiti et Inventioni diverse* (1546) and (posthumously) published an edition of *De Ratione Ponderis* in 1565, entitled as *De Ponderositate*.

[1] It is the characteristic of the *gravitas secundum situm* to consider always two *descents*, instead of comparing the descent of one weight with the ascent of the other. The reason is the nature of the *gravitas secundum situm*, which is defined by means of (only) the descent of weights, so for its application it is necessary to consider the fictive case of the descent of *both* weights.

[2] This summary refers to what Jordanus has exposed in the *Elementa* and *De Ponderibus*. The treatment exposed in *De Ratione Ponderis* is amplified in comparison, countering a serious objection against the treatment of the isostatic balance presented in the other two writings. Tartaglia included in his *Quesiti and Inventioni diverse* a similar amplified theory (with some differences), cf. page 269.

Proposition V (*Quesito* XXXII) in the eighth book of the *Quesiti et Inventioni diverse* treats the isostatic balance (with two equal weights in equal distances): if it is in a horizontal position, it is at rest, and if it is moved an inclined one, it returns to the horizontal position, since the upper weight becomes positionally heavier. He exposes the content of the second proposition of Jordanus's *Elementa*, with substantially the same demonstration, having recourse to his basic concept of *gravitas secundum situm*.
Proposition VI (*Quesito* XXXIII) contains another crucial element in regard since it counters a grave conceptual problematic of the notion *gravitas secundum situm*, which does not permit to compare the *positional* with the *absolute* weight: it is/was unclear if an absolutely heavier weight could equilibrate a smaller weight with a higher positional heaviness as compensation. This is exactly what Ambassador Mendoza, Tartaglia's imaginary interlocutor, objects and what Tartaglia tries to confute subsequently: considering parallel lines of descent, he shows that the vertical components of both weights' descents differ by the magnitude of the curved angle MDG (cf. figure I.7). As this angle is smaller than any rectilinear angle, he concludes that any *absolute* difference in weight would overcome this "infinitesimal" difference in positional heaviness. Consequently, Mendoza's objection would have to be considered as confuted.

Cardano

Cardano has dealt with the balance as well, at the end of the first book of *De Subtilitate*. His description, however, does not clearly indicate if he refers to an isostatic balance or not.[1] In any case, the consideration of Cardano's reasoning and basic concept *angulus a meta* is useful to comprehend the diversity of the different approaches to a such elementary case as constituted by the balance.
The Milanese scholar distinguishes two kinds of balances: one with the suspension support "*trutina*" above the rotation centre B (cf. figure I.8), i.e. in AB, and the other with the *trutina* below the rotation centre, i.e. in BQ. If the beam is imagined in the inclined position FR, with equal weights on it, so the balance will turn to the horizontal position for the first kind of balance. Cardano uses the occasion for a critique towards Jordanus: he would not have treated nor comprehended this case. For the second kind of balances, the beam in FR would move to the vertical position AQ, which would have similarly remained untreated by Jordanus. Interestingly, Cardano refers here to results gained from "experiments".
By adducing the following reason for the different behaviours of the balances, he partly bases himself on a curious interpretation of the treatment of balances in the *Quaestiones Mechanicae*: calling "*meta*", i.e. "goal", the part of the vertical axis AQ that does *not* constitute the *trutina*, Cardano claims that the decisive

[1] In fact, on the one hand he considers the point C to be the rotation centre, on the other hand he speaks of supporting devices on which C is attached.

magnitude would be the angle between the beam and the *meta*: the bigger this "*angulus a meta*" is, the heavier the weight is positionally.

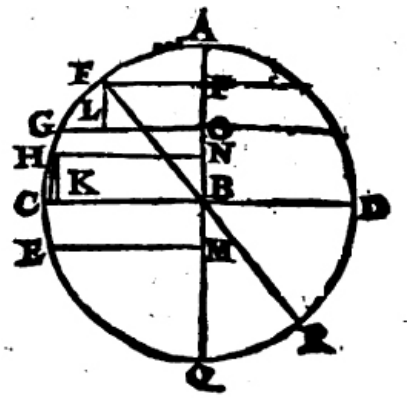

Figure I.8: Cardano's treatment of the balance.

So, for the first case, with the *trutina* in AB, the *angulus a meta* of the weight in F is FBQ, while the one of the weight in R is RBQ. So the weight in F is positionally heavier than the one in R and, consequently, the balance moves to the horizontal position. For the second case instead, the *anguli a meta* are FBA for the weight in F and RBA for the weight in R, so the latter is heavier and the balance reaches the vertical position.[1]

Benedetti

Also after the edition of Guidobaldo's *Mechanicorum Liber*, the question of different types of equilibria continued to occupy the scholars of mechanics. A prove of this fact is the content of the chapter *De Mechanicis* in Benedetti's *Diversarum Speculationum mathematicarum et physicarum Liber* (1585).
After the initial sections, including the exposition of the working concepts of the treatment,[2] Benedetti turns to criticise Tartaglia's and Jordanus's theory of the isostatic balance in *Caput* VII and VIII. Obviously, Benedetti agrees with the first part of Tartaglia's fifth proposition (equal weights from equal distances are in equilibrium in the horizontal position), but not with the second one, according to which the isostatic balance would turn to the horizontal position from an inclined one. The Piedmontese scholar bases his reasoning substantially on

[1] This *angulus a meta* is a problematic magnitude: Cardano does not explain why exactly this angle would be the decisive conceptional element.

[2] The fundamental conceptual elements used by Benedetti in the treatment of the isostatic balance are: the vertical projection to the horizontal axis measures the effective heaviness of a weight attached on an inclined balance arm (*Caput* I & II); *Caput* III instead furnishes a general rule to determine the effective 'force' or weight acting under an arbitrary angle on a lever.

the consideration of *convergent* lines of force, and on the application of his third proposition.[1]
Let us imagine an inclined isostatic balance, with the equal weights in A and B (cf. figure I.9), equally distant from the centre of the balance O. May the lines BU and AU be their *lineae inclinationis* converging in the centre of the world U. Let us draw the perpendiculars from O to these lines of force to the points E on BU and T on the prolongation of AU. As *Caput* III states, the segments OE and OT are the respective measures of the effective heavinesses of the weights in A and B. Benedetti proves geometrically (cf. figure I.10), that OT is bigger than OE.

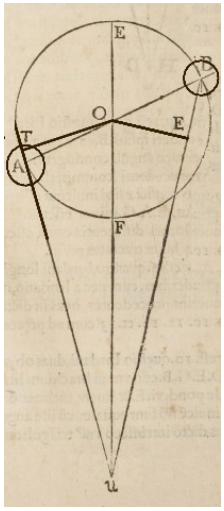

Figure I.9: The measure of the effective weigths in the *Diversarum speculationum Liber*.

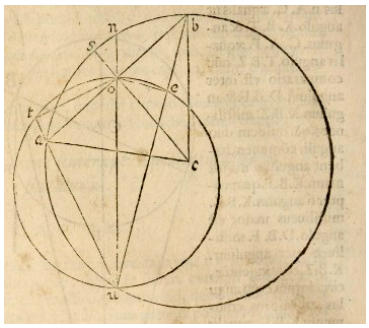

Figure I.10: The geometrical demonstration that OE is smaller than OT.

Consequently, according to Benedetti's theory of how to measure the effective heaviness of "forces"/weights acting along arbitrary directions, the weight in A is effectively heavier than the one in B. Therefore - interestingly, Benedetti does not formulate this explicitly - the balance has to go down at the side of A and hence moves to the *vertical* position.

[1]It is somewhat puzzling that Benedetti in *Caput* VII considers *converging* lines of action, while in the first two propositions of *De Mechanicis* he supposed them to be *parallel*. In fact, the only one who reaches a satisfying compromise between parallel and converging lines of action is Guidobaldo; cf. Part A, IV.2.3. On the content of Benedetti's *Caput* III and Guidobaldo's critique against it, cf. paragraph "*Against Benedetti's* Diversarum Speculationum Liber" of Part A, VI.2.1.

I.1.2 The "unheardness" of Guidobaldo's theory and its compatibility with Archimedes's mechanics

So, subsection I.1.1 has evidenced at least two things: the notable variety of approaches to explain such a simple mechanical device like the balance adn the fundamental divergence of the respective basic concepts on the one hand; on the other, Guidobaldo's isolation with his theory, being contrary to such authorities of mechanics like Aristotle, Jordanus or Tartaglia. The former seems to have attributed the indifferent equilibrium to the balance of unstable equilibrium, whereas Jordanus and his sixteenth-century followers denied the existence of indifferent equilibrium at all. Even after Guidobaldo's *Mechanicorum Liber* - which surely cannot be blamed for the lack of mathematical precision - his approach does not seem to have convinced all scholars of mechanics, as Benedetti's differing treatment testifies.
So, for the theory of the isostatic balance there have been brought forward three fundamentally different theories in a few years' period, all of them basing on dissimilar principals, predicting three diverse reactions of the balance in the inclined position:[1] Jordanus's approach according to which the balance was returning to horizon, using the concept *gravitas secundum situm*, for which Tartaglia had made propaganda in his writings of 1546 and 1565. Then Guidobaldo's solution in the *Mechanicorum Liber* (1577) that argued for a persistence of the balance in the inclined position - basing itself on the Archimedean concept of *centre of gravity*. And finally Benedetti's claim in the *Diversarum speculationum Liber* (1585) that the balance moves to the vertical position, recurring to an idea of decomposition of forces.

Guidobaldo complained about the fact that his theory was not accepted, stating in the dedicatory letter of the *Paraphrasis*: "<In the *Mechanicorum Liber*> I have created many and manifold theorems; yet they appeared to many, many men, who maybe are not used to investigate the causes of things in this way, totally new (as I heard) and wholly *unheard*, and seemed to them not sufficiently sound (as I think)".[2] In fact, section I.3 will show that Guidobaldo met notable scepticism in regard to his "discovery". This reaction by a large part of the scientific community is not incomprehensible on the other hand: the non-existence of indifferent equilibrium was sustained, as exposed above, by the mechanical elite of those times, by authorities like Jordanus, Tartaglia and Cardano, then also by Benedetti; not to mention Aristotle who had not even made a word about the existence of the isostatic balance. And in the end, the conceptional change of

[1] Obviously, in this section we always refer to equal weights attached in equal distances from the rotation point.

[2] *Paraphrasis*, p. i (not numbered): "(...) theoremata multa ac varia construxi. (...) plerisque tamen, qui non admodum fortasse in huiusmodi rerum causis investigandis versati existunt, nova prorsus (ut accepi) ac ferme *inaudita*, nec satis (ut opinor) apud eos firma, atque ideo illis non omnino satisfecisse, visa sunt." The emphasis is ours.

the very foundations of mechanics (here: the basic concept itself of the balance and, hence, of the mechanical machines) could not go smoothly;[1] particularly, because there was no reason to doubt the veracity of Jordanus's theory: it was corresponding to the daily experiences of the scholars of mechanics made, for example, at the marketplaces - this consideration leads directly to a second element:
Practically all balances in use in those times manifested stable equilibrium, whereas an isostatic balance was extremely difficult to fabricate: the centre of rotation had to lie exactly on the beam and to coincide with the centre of gravity of the system: an even minimal discrepancy was sufficient to produce, in contrast, stable or unstable equilibrium. In fact, Guidobaldo made Pigafetta emphasise this aspect in the vulgar translation of the *Mechanicorum Liber*:

> È ben vero che non bisogna correr a furia a far quest'esperienza, per esser cosa molto difficile (come dice l'autor più a basso) a far una bilancia la qual sia sostenuta nel suo proprio centro della gravità. È però d'avertir che quando alcuno si mettesse a far questa esperienza e non gli riuscisse, dica pur risolutamente di non aver fatto bene, e torni a far di nuovo l'esperienza finché la bilancia venghi sostenuta nel centro preciso della gravità.

It is interesting in this context that the word *equilibrium* itself suggests by its etymology how intuitive the association of the conception "state-at-rest" with *stable equilibrium* is: in the Romance languages, and in English as well, the word that denotes a physical state without movement derives from the Latin *terminus* "*aequelibrium*".[2] This word, on its part, is composed by "*aequus*" and "*libra*", i.e. "even, horizontal" and "balance, beam".[3]
Against this background, it seems again the context of Guidobaldo's work which

[1] Even if the existence of indifferent equilibrium might not seem a great theoretic challenge, it leads directly to the non-validity of Jordanus's approach. So, no follower of the *Scientia de Ponderibus* could easily accept Guidobaldo's "discovery". As far as the conceptual change of entire physical fields is concerned from a theoretical standpoint, cf. T.S. Kuhn, *The Structure of Scientific Revolutions*, Chicago, University of Chicago Press, 1962.

[2] The German language, instead, uses the word *Gleichgewicht*, deriving from "*gleich*" (equal) and "*Gewicht*" (weight). It would be interesting to clarify is etymology: on the one hand, it might reflect the experience that a balance of equal arms in "equilibrium" must be endowed with equal weights. On the other hand, a different etymological explanation might refer to a balance with unequal arms: "*Gewicht*", in this case, then means something like mechanical "*moment*", as it is often testified in sixteenth-century mechanics, when "gravitas" is used ambiguously, sometimes as *absolute* weight, and sometimes like the *effective* weight in a certain distance from the fulcrum.

[3] In effect, about the etymological value of this word, cf. Enout-Meillet's "Dictionaire etimologique de la langue latine", p. 19): s.v. 'aequus': "plan dans le sens horizontal, qui ne prèsent pas des inégalités". And a step in Seneca, *Nat. Quaest.* III 25,6, suggests that this value was well documented, when he speaks about the equilibrium of a piece of wood in water. We would like to thank Matteo Martelli for this information.

assumes importance to come to a plausible explanation: Urbino was, as already mentioned, noted for its offices of precision instruments, and the young Guidobaldo had spent much time in Simone Barocci's office. He himself stressed (in a letter to Contarini of 1581) the connections between his mathematical theories and the "experiences" he (had) made with real exemplars of balances and other mechanical machines.[1]
The exiguous part of Guidobaldo's correspondence that has survived contains several hints at the refusal his theory met in the mechanical community: in a letter to G. Giordani he complained that the engineer Silvio Belli did not agree with his theory.[2] Further, the fact that he sent isostatic balances both to Pinelli and Pigafetta, as section I.3 will document, hints at the necessity he must have felt to convince his Paduan interlocutors by means of material experiences - the mathematical demonstration does not seem to have been sufficient to do this. Then, some years later, in the *Paraphrasis*, Guidobaldo speaks of "many, many men" who did not agree with the indifferent equilibrium in the *Mechanicorum Liber*; and another decade later, a member of the Mathematical Academy of Madrid attacked Guidobaldo vehemently for his theory of the isostatic balance.[3]

If the scepticism of the mechanical scholars towards Guidobaldo's theory is to some extent comprehensive, on the other hand it might seem surprising: in fact, Guidobaldo's theory is in plain accordance with Archimedes's mechanics. Therefore, it is not difficult to understand Guidobaldo's complaint in the preface of the *Paraphrasis*: his theory was a direct consequence of the Archimedean theory of *barycentre* - or, at least, the Archimedean theory according to its interpretation by Pappus, with his definition of *centre of gravity.*
In fact, Archimedes had demonstrated in the fourth proposition of the *Equilibrium of Planes* (cf. figure I.11):[4]

> If two equal magnitudes do not have the same centre of gravity, so the centre of gravity of the magnitude which is composed by the two <initial> magnitudes will be located in the middle of the straight line that links the centres of gravity of the <initial> magnitudes.[5]

[1]For Guidobaldo's acquantainces and collaboration with Simone Barocci, cf. Part A, I.2. For his use of precision instruments, cf. Part A, IV.1.1 and Appendix I, I.8.2.

[2]The respective passage of this letter is exposed in Part B, I.3. Silvio Belli was an engineer of some importance, *inter alia Proto delle acque* of the Venetian Republic and *Ingegnere ducale* of Alfonso II d'Este; cf. A. Fiocca, *Silvio Belli ingegnere: empiria e matematica nella cultura tecnica del Rinascimento* in D. Biancardi, F. Cazzola, *Acque e Terre di Confine. Mantova, Modena, Ferrara e la Bonifica di Burana*, Ferrara, Editrice Cartografica, 2000, pp. 15-50.

[3]Cf. Part B, I.4.4.

[4]In reality, there are several elements of Archimedes's mechanics indicating that the barycentre of two equal magnitudes is situated in the middle between their centres of gravity: it can be deduced, for example, from Axiom V (stating the similar positions of the barycentres in similar figures), with the application of a simple symmetry-argument.

[5]Cf. *Paraphrasis*, p. 42: "Si due magnitudines aequales non idem centrum gravitatis habuerint, magnitudinis ex utrisque magnitudinibus compositae centrum gravitatis erit medium

Admittedly, Archimedes's definition of *centre of gravity* has not come down to us, so Guidobaldo's affirmation cannot be directly deduced from this proposition. Yet, Pappus has transmitted the following definition of *centre of gravity* in the eighth book of the *Collectiones Mathematicae*:

> We call *centre of gravity* a certain point of any body within it, from which, if it is imagined to be suspended and held, it remains stable and maintains the position which it had at the beginning, and is not set to rotating in this suspension.[1]

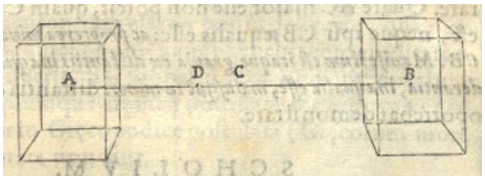

Figure I.11: The illustration of the fourth proposition of the *Equilibrium of Planes* in Guidobaldo's *Paraphrasis*. Archimedes's demonstration is a prove by contradiction, supposing that the centre of gravity of A and B is not C, the middle point, but D.

With this definition, Guidobaldo's theory was in conformity with Archimedes's - with the two elements that the centre of gravity of two equal magnitudes is located in the middle point of the line linking their centres of gravity, and that a body sustained in its centre of gravity stands still. In fact, there is a clue that Archimedes, as well, was aware of the existence of indifferent equilibrium:[2] in the first proposition of his *Method*, he determines the area of the parabola,[3] using the following mechanical reasoning: it considers an idealised balance that links the points Θ, K and Γ (cf. figure I.12), postulated to be in equilibrium. As the figure evidences, this balance is clearly inclined - the deciseive characteristic of the indifferent equilibrium of the isostatic balance.[4]

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rectae lineae gravitatis centra magnitudinum coniungentis."

[1]"Dicimus autem centrum gravitatis uniuscuiusque corporis est punctum quoddam intra positum, a quo si grave dependens mente concipiatur, dum fertur, quiescit et servat eam, quam in principio habebat positionem, neque in ipsa latione circumvertitur." Cf. Pappus, *Collectiones Mathematicae*, Librus octavus, translation by F. Commandino, revised by Guidobaldo, fol. 306v.

[2]We would like to thank Professor Napolitani for this suggestion.

[3]To be precise, the very concept "area" is absent in Greek mathematics. In reality, Archimedes determines the *ratio* between the parabola and the inscribed triangle, having the same basis and height, to be as 4 to 3.

[4]It does not seem plausible that the figure was decisively changed in the course of the centuries: if one would suppose that the balance was in Archimedes's original design in an horizontal position, the parabola would have to be situated in a very strange way which does not

As the following sections will reveal, Guidobaldo's reaction against his critics was harsh and resolute. One reason for this behaviour was that the non-existence of indifferent equilibrium - conversely - was not compatible with Archimedes's mechanics: it would have implied the non-validity of the concept *centre of gravity*. Jordanus and Benedetti claimed that the balance, even if held in its middle point (its barycentre!), would move - and this contradicts, as shown above, the Archimedean theory (surely according to Pappus's interpretation, and most probably also in its original version by Archimedes).

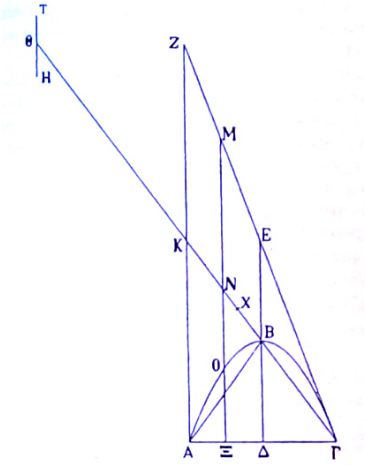

Figure I.12: The figure illustrating Proposition I of the *Method*.

Guidobaldo was fully aware of the conceptual relevance of this question - he introduced his long confutation of Jordanus's, Cardano's and Tartaglia's arguments after the fourth proposition in the *Mechanicorum Liber* with the words:

> Since many claims, made by some scholars[1], holding other opinions, seem to be in contrast to this last result, it will be useful to dwell a little bit on this topic. I will use my best endeavours to defend *not only my own* opinion, but *also Archimedes himself who seems to have been of the same opinion*.[2]

So let us have a look at the treatment of the topic in the *Mechanicorum Liber* in the following section.

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seem probable at all. Further, the *Method* does not seem to have suffered textual corruptions, in contrast to other works of his, like the *Measurement of the Circle* or the *Equilibrium of Planes*.

[1]The marginal note explicitly cites Jordanus's *De Ponderibus*, Cardano's *De Subtilitate* and Tartaglia's *Quesiti et Inventioni diverse*.

[2]*Mechanicorum Liber*, fol. 5v: "Quoniam autem huic determinationi ultimae multa a nonnullis alteriter sentientibus [*in marg.* Iordanus *De Ponderibus*, Hyeronimus Cardanus *De Subtilitate*, Nicolaus Tartalea *De Quesitis ac Inventionibus*] dicta officere videntur, idcirco in hac parte aliquantulum immorari oportebit. Et pro viribus *non solum propriam* sententiam, sed *Archimedem ipsum, qui in hac eadem esse sententia videtur*, defendere conabor." The emphasises are ours.

I.2 The importance of the topic in the *Mechanicorum Liber*

The indifferent equilibrium is exposed in the first chapter "*De Libra*" of the *Mechanicorum Liber*. Even if it may seem a marginal subject in a work dedicated to the Simple Machines, Guidobaldo must have attributed considerable importance to it, from the very beginning.
This is more than comprehensive, considering both its role for the explication of the Simple Machines (cf. I.2.3) as well as obviously its sharp contrast to other theories of the balance (cf. I.2.1 and I.2.2).

I.2.1 Preface: polemic against the *Scientia de Ponderibus*

Already in the preface, Guidobaldo leaves no doubt which model of mechanics he considers the right one: Archimedes's. In his *On the Equilibrium of Planes* would be contained almost all "*mechanica dogmata*". Further, many statements regarded as true by "this age's mathematicians" would be confuted and demonstrated as wrong in the Syracusan's treatise.[1] Even if Guidobaldo is not more explicit about this topic, this critique is referred to the followers of the *Scientia de Ponderibus*: this becomes clear a few pages later when Guidobaldo explains why he has introduced his work with a chapter about the balance which, in fact, is not directly connected with the topic of the Simple Machines. One cannot help but wonder, as the Marchigian mathematician emphasises almost angrily, how disastrously Jordanus and his followers (like Tartaglia and Cardano, who are named in the fourth proposition) have treated this subject.[2] As the following subsection will testify, this innuendo clearly relates to the indifferent equilibrium: after the fourth proposition of *De Libra*, Guidobaldo extensively dwells on Jordanus's, Tartaglia's and Cardano's errors who had brought forward numerous arguments why the isostatic balance would not rest in an inclined position.

[1] *Mechanicorum Liber*, p. vi-vii (not numbered): "Ego enim in hac praesertim facultate Archimedis vestigiis haerere semper volui. Et licet <Archimedis> lucubrationes ad mechanicam pertinentes multis ab hinc annis passim soleant doctis desiderari: eruditissimus tamen libellus *De Aequeponderantibus* prae manibus hominum adhuc versatur, in quo tanquam incopiosissima poenu omnia fere mechanica dogmata reposita mihi videntur. Quem sane libellum, si aetatis nostrae mathematici sibi magis familiarem adhibuissent, reperissent sane sententias multas, quas modo ipsi firmas et ratas esse docent, subtilissime atque verissime convulsas et labefactas."

[2] *Mechanicorum Liber*: p. x (not numbered): "Verum quo facilius totius operis substructio ad fastigium suum perduceretur, nonnulla quoque de libra fuerunt pertractanda et praesertim dum unico pondere alterum solum ipsius brachium penitus deprimitur: Qua in re mirum est quantas fecerint ruinas Iordanus (qui inter recentiores maximae fuit auctoritatis) et alii qui hanc rem sibi discutiendam proposuerunt."

I.2.2 Proposition IV *De Libra*

To deduce the importance of the topic it suffices to take into consideration its mere physical extension: the digression after the fourth proposition, in which Guidobaldo justifies his own theory and contemporaneously attacks the contrasting theories, occupies some fifty pages, which means a 1/5 of the entire work. And all this for *only one* proposition that is a *part of a chapter* that *does not actually belong* to the subject of the Simple Machines.[1] This fact is even more astonishing if one considers that Proposition IV also covers as much space as the chapters about winch, wedge and screw taken *altogether*.
So, this proposition merits a closer look - its argumentation could be subdivided in the following way (cf. table I.1):

1. The direct prove of the existence of indifferent equilibrium (fol. 5r/v)
2. Incompatibility of the *gravitas secundum situm*-theory with the Archimedean mechanics (fol. 6r/v)
3. The convergence of the lines of action (fols. 6v-8r)
4. *Excursus*: The positional heaviness of a weight on a rotatable balance arm and the position variation of the point of highest positional heaviness depending on external parameters (fols. 8v-15r)
5. Intrinsic contradictions of Jordanus' theory and proposals for modifications to the *gravitas secundum situm* (fols. 15v-19r)
6. Converging versus parallel lines of action (fols. 19v-20v)
7. Against Cardano (fols. 20v-23r)
8. Defense of Aristotle's treatment of the balance with an excursus on balances of stable and unstable equilibrium (fols. 23r-28v)
9. Generalizations and conclusive considerations (fols. 28v-30r)

Table I.1: The argumentative structure of Proposition IV.

So, two levels could be distinguished in Guidobaldo's digression: on the one hand, the direct existence prove of the indifferent equilibrium, with the elucidation that his own theory is in accord with Aristotle's (points 1 and 8). On the other, the confutation of contrasting theories, exposed by Jordanus, Tartaglia and Cardano, this second "level" having a clear prevalence. According to the scholium

[1] Surely, the treatment of the balance was the necessary theoretical foundation of the work - yet, one cannot help but wonder about the remarkable length and detailedness of the chapter *De Libra* in general, and of Proposition IV in particular.

that Guidobaldo would have made Pigafetta add in the Italian translation *Le Mechaniche* (cf. I.4.1), the Marchigian mathematician followed in this attack against his adversaries the Aristotelian logical model of how to conduct a scientific dispute: the adversaries' arguments should be confuted and the own ones motivated.[1] Guidobaldo's exhaustive, sometimes excessive, style entails however, that this digression, more than an argumentation in favour of indifferent equilibrium, sometimes might seem rather a reckoning with Jordanus and his followers. The successive paragraph exposes a summary of the Guidobaldo's argumentation - a more detailed analysis can be found in Part A, IV.2.2.

After the elementary direct prove of the existence of the indifferent equilibrium,[2] the first thematic unit approaches the incompatibility of the *gravitas secundum situm*-theory with Archimedes's theoretical foundations. In this occasion, Guidobaldo applies the Archimedean notion of *centre of gravity* to Jordanus's statements, and interprets "positional heaviness" as something really measurable (and counterbalanceable with a *real* weight).

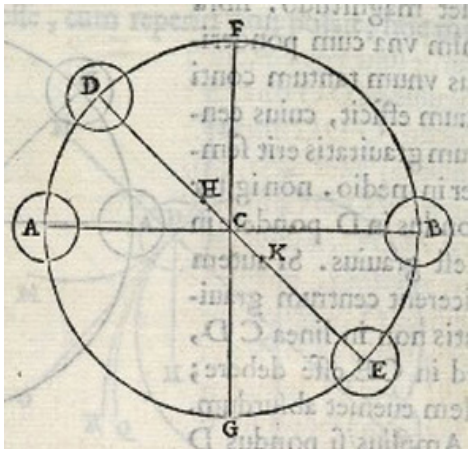

Figure I.13: The incompatibility of the notion *centre of gravity* with the *gravitas secundum situm*-theory.

Jordanus and Tartaglia had claimed that the upper weight in D is positionally heavier (cf. figure I.13). So, the barycentre of the inclined balance must have

[1]The passage in *Le Mechaniche* reads (fol. 29r): "Et affineché questa nova opinion sua <l'equilibrio indifferente>, dimostrata a pieno nella predetta quarta propositione, resti totalmente chiara, non si è già contentato egli <Guidobaldo> d'haverla dimostrata con vive ragioni et certe solamente, ma come buon filosofo, procedente con via di reale dottrina et di fondata scienza (imitanto Aristotele, il qual ne' principii de' suoi libri, investigando dottrina migliore, ha datto contra la opinione degli antichi, sovendo le ragioni addotte da loro), ha ben voluto, essendo la verità una sola, proporre le opinioni de' suoi predecessori, et esaminare le loro ragioni, le quali sembrano provar il contrario, et solverle, la loro fallenza dimostrando col presente discoro (...)." The whole letter is reported in Part B, section I.4.1.

[2]Cf. in Part A, IV.2.2.

moved nearer to the positional heavier weight, e.g. to H, in respect or the horizontal position with centre of gravity in C. But this would be impossible, since the second *Suppositio* postulated that the barycentre position of any body is invariant against translations and rotations.[1]
Guidobaldo brings forward a second analogous argument: if the weight in D is really supposed to have become positionally heavier (and to move downwards, consequently), an additional counterweight can be added in E so that the balance held in C stays at rest in the inclined position DE all the same (again, cf. I.14).[2] Yet, with this addition the centre of gravity of the "system balance" is displaced in direction of E - say in K. For the property of the centre of gravity, the system will stay at rest if and only if held in K:[3] and this is a contradiction to the aforesaid hypothesis that the balance remains at rest if sustained in C.

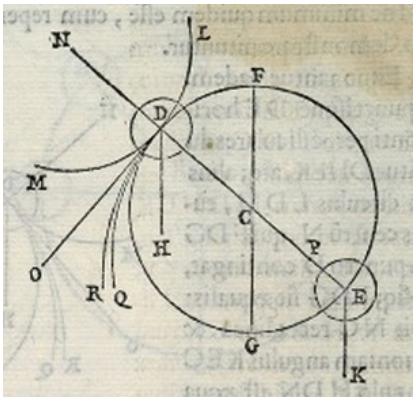

Figure I.14: Tartaglia had argued that the curved angle MDG (which measures the difference of positional heaviness between the two weights) is minimal.

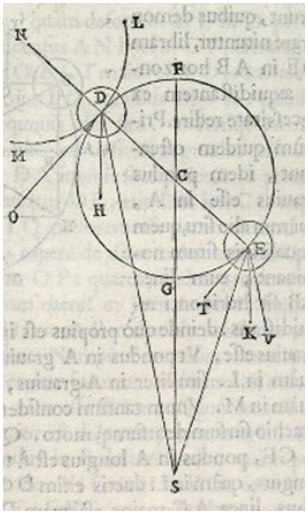

Figure I.15: Guidobaldo's consideration of convergent lines of action.

It is now that Guidobaldo's "notorious" argument of the converging lines of action enters the stage. In this way, he counters Tartaglia's objection to the aforesaid argument: the latter, replying to Mendoza's objection in the *Quesiti et Inventioni diverse*, had denied that there can be found a weight so light to counterbalance the positionally heavier weight. Any *real* weight, *absolutely* heavier, would overcome the advantage of positional heaviness. He had justified this by

[1] *Mechanicorum Liber*, fol. 1v: "*Suppositio* II Unius corporis centrum gravitatis semper in eodem est situ respectu sui corporis."

[2] This argument is similar to the one exposed by Mendoza in the eighth book of the *Quesiti et Inventioni diverse*, cf. I.1.1. Yet, Mendoza obviously does not recur to the notion of *centre of gravity*.

[3] For three-dimensional bodies there are also other points besides the barycentre, obviously, from which a body can be held in order to stand still. Yet, in this case of the inclined isostatic balance (which is not in a vertical position!), only held in the barycentre it stays at rest.

adducing the fact that the positional heaviness gives only an infinitesimal advantage to the upper weight. The difference of the heavinesses would be given by the curvilinear angle MDG which is smaller than any rectilinear angle (cf. figure I.14). Hence, as Tartaglia concludes, the ratio between weights with a different positional heaviness is smaller than it could be between any *absolutely* different weights.
Guidobaldo indicates that both Jordanus and Tartaglia had admitted that the lines of action were in reality converging to the centre of the world, but none of them would have abode by their own supposition. He instead proves, considering their convergence (cf. figure I.15), that "in reality" the upper weight is positionally *lighter* than the lower. So, he concluded, if Jordanus and Tartaglia had applied their own theory in the right way, they would have come to the contrary result compared to the one they had presented.

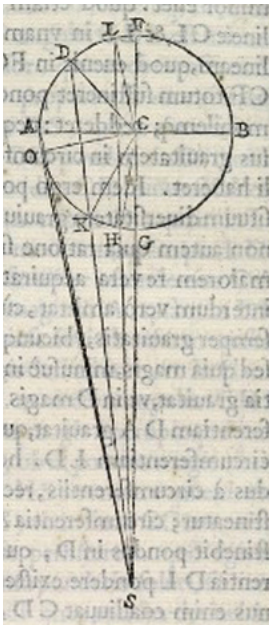

Figure I.16: According to Guidobaldo, the weight is heaviest in O, contact point of tangent from S and the circumference.

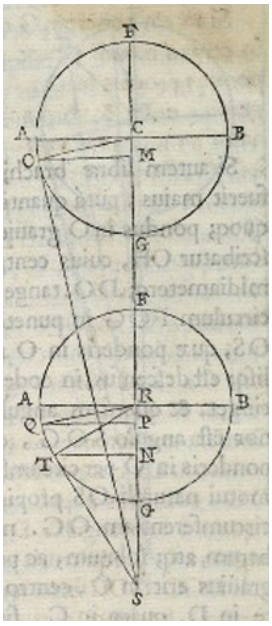

Figure I.17: The variation of the position of the contact point O (and T in the second case).

Next, Guidobaldo begins a long excursus asking for which inclination a weight on a single, rotatable balance arm is heaviest. This question is not strictly related to the topic of indifferent equilibrium, but clearly belongs to the context of Guidobaldo's confutation of central elements of the *Scientia de Ponderibus*: in effect, its followers claimed that a weight attached to a rotatable balance arm, is heaviest when the beam is in the horizontal position.

Guidobaldo does not negate that the "effective" heaviness of a weight on a rotatable balance does change according to the inclination of the beam. Yet, the concept *gravitas secundum situm* would be unsuitable to explain this fact. Instead, simply the different extent to which the weight rests upon the beam would be responsible for this phenomenon. Similarly, he contradicts Jordanus and Cardano regarding the position of the highest positional heaviness. The weight is heaviest in O, not in A (cf. figure I.16; O being the contact point of the tangent to the circumference, described by the rotation of the balance arm, drawn from the centre of the world S). By doing so, he adopts the idea of comparing the "actual" and, on the other hand, the "natural" path of descent of the weight on the beam.[1]

Afterwards, Guidobaldo turns to highlight some grave intrinsic contradictions of the *gravitas secundum situm*-theory, giving a taste of so his mathematical abilities: according to the *gravitas secundum situm*-theory, the positional heaviness of a weight is measured by the vertical component of its (hypothetical) movement, along arcs of equal length on the same circumference. But then, Guidobaldo objects, on the one hand the same weight is positionally equal heavy in D and in A (cf. figure I.18), since the respective descents along the arcs DA and AN have the same vertical component OC and CT (symmetry!).
On the other hand, the consideration of the weight's descent from D to A piecewise yields a completely different result: if the arc DA is divided, for example, in three equal parts by the points K and S, the weight surely is positionally lighter in D than in K, and lighter in K than in S. Moreover, as the weight is not heavier in S than in A, it can be concluded that the weight is positionally lighter in D than in A, in contradiction to the consideration above.

There is another element of Jordanus's theory that Guidobaldo explicitly criticises: with which right does the *gravitas secundum situm* consider *only the descents* of two weights on a balance? Would not it be more appropriate to compare the descent of one weight with the ascent of the other, according to the fact that one weight has to go down if the other goes up?[2]
Correspondingly, Guidobaldo demonstrates in the following that, modifying the concept *gravitas secundum situm* for the consideration of *one descent* and *one ascent* in the first case, or, in the second, of *two ascents*, one obtains wholly different solutions for the behaviour of the inclined isostatic balance: in the first

[1] The position of this contact point obviously varies in function of the distance between the centre of the circle and the centre of the world. A more detailed description of Guidobaldo's argumentation is exposed in Part A, IV.2.2.

[2] In effect, what at first glance might seem a somewhat silly question turns out to be a justified objection: for us modern readers, familiar with physical notions like *potential* or *kinetic energy*, comparing two descents does not seem strange. At Guidobaldo's times, though, this must have seemed arbitrary, almost as a principle adopted in order to prove exactly what had to be shown.

case, the balance would stay at rest (cf. figure I.19), in the second it would move to the vertical position.

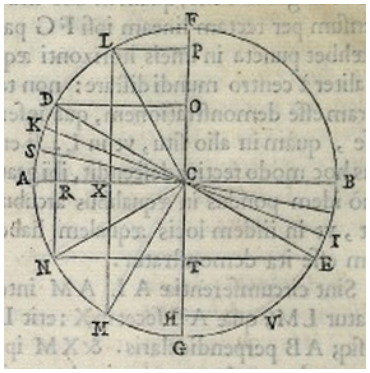

Figure I.18: Guidobaldo evidences a conceptual weakness of the *gravitas secundum situm*-theory: according to which descent of the weight in D is considered, it turns out to have respectively equal or less positional heaviness than the one in A.

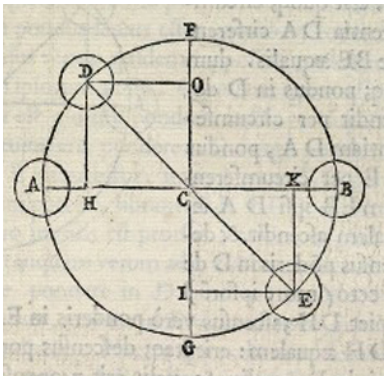

Figure I.19: Guidobaldo complains about the consideration of two *descents* of the weights on the balance in the *gravitas secundum situm*-theory. He suggests to instead compare the descent with the ascent of the other weight.

Afterwards, Guidobaldo turns to the topic of converging *versus* parallel lines of action. This is not a mere play of thought without far-reaching conceptual consequences: in fact, even if Guidobaldo had considered convergent lines of action on the pages before, the Archimedean *centre of gravity*-concept is based upon the supposition of *parallel* lines of action: otherwise, the very concept *centre of gravity* would not be well-defined.[1] Thus, the conceptual brisance of the topic should not be underestimated.

Guidobaldo presents a compromise between the "Aristotelian"[2] idea of converging lines of action and the Archimedean theory of parallel ones:

He confirms that the lines of action of the weights in D or E, considered *autonomously*, are converging, i.e. constituted by DS and ES (cf. figure I.20). However, when the weights would be connected by the device of the balance, they would constitute one single body, with centre of gravity in C. If it is left free to move, the balance, in quality of a *heavy body* in the Aristotelian sense, would fall towards the centre of the world S moving along a straight line, until S coincides

[1] The concept *centre of gravity* is well-defined only in the case of parallel lines of action, cf. Part B, II.4.6, which exposes a more detailed analysis of this problem. Interestingly, Archimedes himself took into consideration converging lines in *On Floating Bodies*.

[2] "Aristotelian" in the sense that according tot Aristotle's natural philosophy every *heavy body* tried to reach the centre of the world (as its *natural place*), on the straight line. The conceptual implication of this reasoning is the consideration of *converging* lines of action.

with C, in quality of barycentre of the balance-system. As the movement happens along a straight line and as the balance does not rotate during this movement, the weights formerly in D and E respectively cover the paths DH and EK. Thus, these two lines have to be considered as the actual lines of action, in the case of the conjunction of the weights by the device of the balance. So, their connection, and consequently the modification of their "physical identity" (from that moment, they constitute a single, composed entity), effects that the very lines of action change.[1]

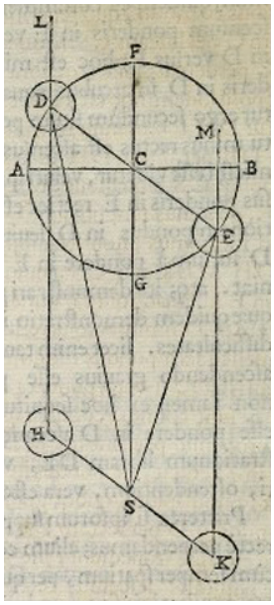

Figure I.20: Guidobaldo's compromise between parallel and converging lines of action.

After the confutation of another argument brought forward by Cardano,[2] Guidobaldo turns to defend Aristotle's treatment of the balance in the *Quaestiones Mechanicae*, adopting a principle in a certain way similar to the one used in its *Quaestio* I: Aristotle distinguishes two different ways of movement in regard of a weight attached to a balance ("circle"), one is the "natural" movement, along

[1]Now, one could wonder why Guidobaldo criticised Tartaglia for the consideration of parallel, instead of converging lines of action, if he himself did the same. Yet, the former's critique is not incoherent: the difference is that the *gravitas secundum situm* always considers the weights *separately*, as evidenced by the considerations about the position of highest positional heaviness of a single weight fixed to a rotatable balance arm, or by the consideration of *two* descents for the case of the inclined isostatic balance, as if every weight were not connected on the balance. In this case of *autonomous* weights, the lines of action have to be considered as converging ones, according to Guidobaldo.

[2]Cardano had claimed that the bigger angle of the upper weight towards the *meta* would effect that the upper weight on the inclined isostatic balance would be positionally heavier. For a more detailed exposition of this argument and Guidobaldo's confutation, cf. Part A, IV.2.2.

the tangent, the other is the "forced" one, along the radius. Also Guidobaldo distinguishes two movements: the one along the circumference as the forced one, and the hypothetical one along the lines of action as the natural one.

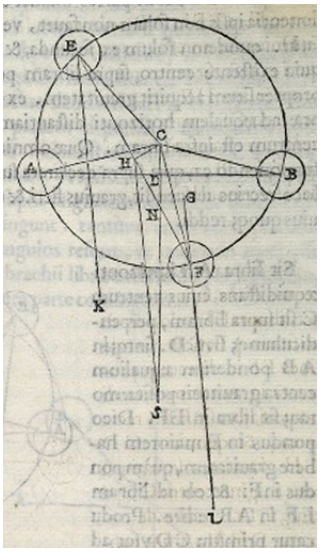

Figure I.21: The demonstration of stable equilibrium recurring to the consideration of the lines of descent.

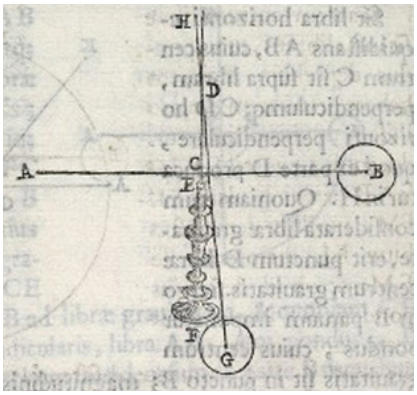

Figure I.22: Guidobaldo's attempt to defend the second part of Aristotle's *Quaestio* II.

With this "Aristotelian" principle,[1] he shows that the equilibrium of a balance with the rotation centre above the beam is stable (cf. figure I.21), and the unstable for the balance with the rotation centre below (as he had already proved in *Propositio* II and III of *De Libra*, recurring to exclusively Archimedean notions).[2] Then, he approaches a problem of the second question of the *Quaestiones Mechanicae*: it seems that the Stagirite had claimed that a balance of unstable equilibrium would rest in the inclined position. Interestingly, Guidobaldo tries to defend Aristotle at (almost) all costs and finds a tricky solution for this situation: according to his interpretation, the latter in reality referred to a real balance like in figure I.22, and to the extreme case in which the beam touched the supporting device. He would have been fully aware of the fact that the lower weight actually was about to move downwards, but was hindered by the support and thus remained at rest as claimed in *Quaestio* II.[3]

[1] In fact, in a certain sense, Guidobaldo applies the idea presented of regarding two different kinds of motion, presented at the beginning of the *Quaestiones Mechanicae*, to the (Aristotelian) conception that the *natural place* of a *heavy body* is situated in the centre of the world and that the body tries to get there along a straight line if it is free to move.

[2] Between, Guidobaldo makes an excursus about the position in which the balance moves fastest. This can be considered as *one* of the arguments against the widespread opinion that Guidobaldo was not interested in "dynamics".

[3] Guidobaldo's intention to defend Aristotle here, even with a rather flimsy argument is in

Generalisations of the results in the Propositions II-IV and considerations on angular and bent balances constitute the end of the digression after the fourth theorem.

I.2.3 The function of the indifferent equilibrium in the *Mechanicorum Liber*

The precedent subsections have documented how much importance Guidobaldo attributed to the topic of the isostatic balance. Yet, the theory of the indifferent equilibrium was connected also with the rest of the book's content: in effect, it did not represent a theoretic curiosity, but a necessary foundation of Guidobaldo's theory of the Simple Machines (with even more profound consequences, as Part B, chapter II will show). In fact, he himself underlines that the treatment on the balance is the theoretical foundation upon which the theoretical structure of the Simple Machines rests.[1]

This statement is confirmed by an analysis of the single treatments of the Simple Machines. There, Guidobaldo often recurs to the indifferent equilibrium, showing that the forces or weights applied at certain machines are in equilibrium, also in cases when they do not act in the horizontal plane.
An example of the use of this idea is the fifth proposition in the chapter *De Vecte* stating that the inclination of the lever is not relevant: the force necessary to sustain the weight is determined exclusively by the respective distances of the force/weight to the fulcrum (cf. figure I.23).[2] So even if the levers AHG and AKF are inclined, this does not change the fact that the *potentia sustinens*[3] and the weight have the inverse proportion of the distances to the fulcrum.[4] So, in the case of the upper lever with fulcrum in K, the relation between *potentia*

clear contrast to his severe judgement towards Jordanus', Tartaglia's and Cardano's theories. The motivation of this fact might have been that Guidobaldo tried not to contradict also Aristotle: he had already criticised Jordanus, Tartaglia and Cardano and was proposing a quite "revolutionary" theory. Probably, he was interested in evidencing that it did not contradict other treatments, especially those of such authorities as Aristotle or Archimedes.

[1] Cf. footnote 2 on p. 277.

[2] *Mechanicorum Liber*, fol. 43v: "Potentia quomodocunque vecte pondus sustinens ad ipsum pondus eandem habebit proportionem, quam distantia a fulcimento ad punctum, ubo a centro gravitatis ponderis horizonti ducta perpendicularis vectem secat, intercepta, ad distantiam inter fulcimentum et potentiam."

[3] Guidobaldo's theory includes the distinction between *potentia sustinens* and *potentia movens*: the former is sufficient to hold the respective weight (with the relations of the law of the lever), but is too small to move the weight. In fact, in Guidobaldo's belief, a greater force is necessary to move a weight than to simply hold it. A more detailed description of this aspect, is exposed in Part A, IV.2.4.

[4] The distance between weight and fulcrum is measured from the point of intersection of the lever and the vertical line from the centre of gravity of the weight.

sustinens and weight D is like LK to KF. This result would not hold in the case of the non-existence of the indifferent equilibrium.[1]

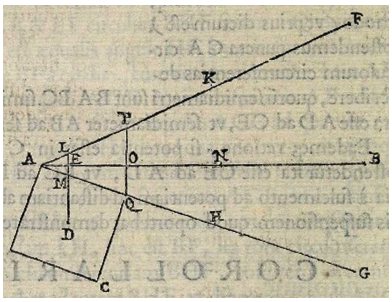

Figure I.23: Proposition V of *De Vecte*: Guidobaldo considers three levers with fulcra respectively in K, N and H.

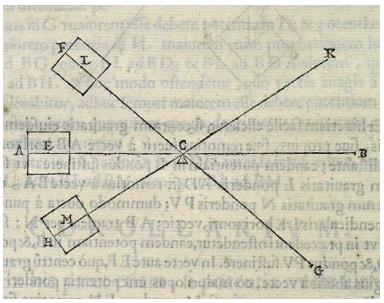

Figure I.24: Proposition X of *De Vecte*: in no matter which inclination the lever is, the relation between weight and *potentia sustinens* remains the same.

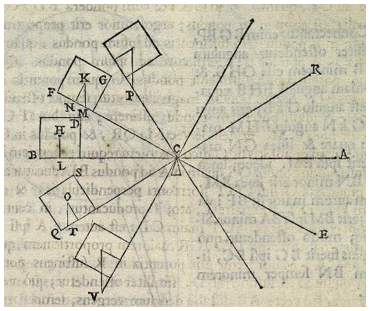

Figure I.25: If the weight is fixed above the lever beam, the relation between weight and *potentia sustinens* does not remain the same.

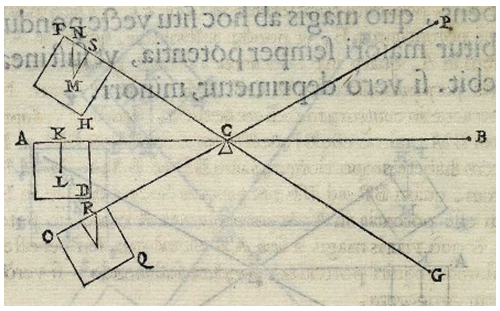

Figure I.26: If the weight is fixed below the lever beam, the relation between weight and *potentia sustinens* does not remain the same.

The theoretical implications of the indifferent equilibrium are even more articulate in the tenth proposition of *De Vecte*.[2] Guidobaldo there states that, in no matter which inclination the lever is moved (cf. figure I.24), the relation between *potentia sustinens* and weight remains always the same, as long as the barycentre of the

[1] In fact, for a theory like the one basing on the *gravitas secundum situm* it would not be possible, as the inclination of (the balance and consequently also of) the lever mutates the relation of the applied forces.

[2] *Mechanicorum Liber*, fol. 55v: "Propositio X: Potentia pondus sustinens in ipso vecte centrum gravitatis habens, quomodocunque vecte transferatur pondus, eadem semper, ut sustineatur, potentia opus erit."

attached weight lies on the lever. Yet, the implications for the lever are not trivial.[1]
Another example of the consequence of the indifferent equilibrium is Guidobaldo's treatment of the winch. The corollary of Proposition I in *De Axe in Peritrochio* determines the force necessary to hold the weight, even if it is not applied in the horizontal plane (cf. figure I.27). The demonstration states that the ratio between the *potentia sustinens* applied in T and the "equilibrated" weight K, fixed in B by a filament, is like the one between BI and IT. This, again, could not be demonstrated with the *gravitas secundum situm*-theory, which negates the existence of the indifferent equilibrium.

Conclusively, the consideration and application of the indifferent equilibrium is by no means limited to the chapter *De Libra*. Rather, Guidobaldo's theory of the Simple Machines presented in the *Mechanicorum Liber* is clearly conditioned by his conception of the existence of indifferent equilibrium and not thinkable, in its present form, without it.

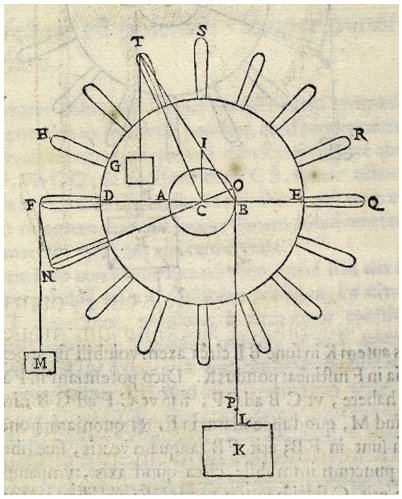

Figure I.27: The figure illustrating the Corollary of Proposition I in *De Axe in Peritrochio*.

[1]In fact, one should not think that these statements are banal, for the lever, in the end, is substantially identical to the balance, from a theoretical standpoint. On the contrary, Guidobaldo develops a rather elaborate theory of the lever distinguishing the ways in which the weights are fixed to the beam - which leads in two cases to varying forces depending on the inclination of the levers, cf. figures I.25 and I.26. Only the case illustrated in figure I.24 maintains the same relation between weight and *potentia sustinens*, independently from the inclination, thanks to the indifferent equilibrium.

I.3 Its reception in the centres of mechanical studies and Guidobaldo's attempts to convince his critics

The *Mechanicorum Liber*, in general, had a deep impact on mechanics, not only on mathematicians but also on members of the "intermediate cultural stratum" like engineers or military captains,[1] to whom it allowed to systematise and arrange their practical experiences. Surely, this was in large parts owed to the topic of the Simple Machines that must have caught the spirit of that age – manifested in a conspicuous number of treatises on mechanical machines published in the sixteenth century. Moreover, also Guidobaldo's clear style of presenting the operation mode of the Simple Machines, evidencing the underlying geometrical rules, must have favoured the authority the text gained in the decades after its publication. Yet, also the effect of Guidobaldo's "unheard" theory of indifferent equilibrium seems to have been considerable:
In effect, one might speak of a "dichotomous" reception: on the one hand, the treatment of the mechanical machines was surely useful to more technically orientated scholars like architects or military captains. The indifferent equilibrium, on the other hand, had a notable impact on scholars who were interested in the conceptual systematisation of mechanics; its practical application, on the contrary, was limited to isostatic balances which were precision instruments and consequently not at the disposal of the generality of the scholars.
This bi-partition is reflected also in Guidobaldo's correspondence: on the one hand, he was approached with questions, why a certain machine did not manifest the rules proved in the treatise, how to construct those machines, how to avoid friction etc. And on the other hand, there is quite a pretty number of letters which deal with the subject of the indifferent equilibrium. The analysis of his correspondence suggests that this second aspect of the reception of the *Mechanicorum Liber* was even more important in Guidobaldo's eyes, given its consequences for the very foundation of his and the Archimedean mechanical theory.
The present section exposes some documents that permit us to perceive the extent and intensity of the discussion triggered by Guidobaldo's treatment of the isostatic balance.

The first extant notice concerning the reception of the indifferent equilibrium is Guidobaldo's letter to Giulio Giordani of February 6th 1579. The former had apparently received a letter of Giordani, who dwelt at Naples in those times,[2]

[1] For further information on C. Maccagni's notion "intermediate cultural stratum", cf. p. 84, particularly footnote 3.

[2] Giordani, a friend from earliest childhood, had become secretary of Isabella della Rovere. The sister of Francesco Maria II della Rovere had married the Prince of Bisignano in 1565, on his part member of an influential family of the Reign of Naples.

who told him about a (not explicitly named) mathematician that had praised the *Mechanicorum Liber*.[1]

> I was very pleased that you have given my book <*Mechanicorum Liber*> to that skilled man - (as your Lordship says very well) praising Commandino's things, he is necessarily talented. The fact that he lauds my book, is surely to be attributed to his kindness and not to my merit. Should you talk with him, I would be pleased if you asked him what he thinks about that *new opinion* in the chapter *De Libra*; the one, I mean, with which Silvio Belli did not want to agree.[2]

This passage is interesting for several reasons: of all the aspects treated in the *Mechanicorum Liber*, Guidobaldo is particularly interested in the mathematician's opinion about the indifferent equilibrium,[3] that Guidobaldo calls "the new opinion". So he was fully aware of the conceptual novelty of his theory.
Further, the letter furnishes information about a not unknown scholar that did not agree with Guidobaldo's theory: Silvio Belli.[4] Probably, it is no coincidence that it is a member of the intermediate cultural stratum that did not agree: he presumably was more familiar with the every-day-experiences with balances (of stable equilibrium) than with reflections on the conceptional foundation of mechanics. In fact, from a theoretical standpoint, Guidobaldo's theory was not so difficult to accept (at least for followers of Archimedes's approach to mechanics).

Then, the question came to the fore another time, in occasion of Pigafetta's works on the translation of the *Mechanicorum Liber*: not less than twelve[5] letters

[1]Unfortunately, the mathematician in question is not called with name. A consultation with prof. Romano Gatto, scholar of the history of mechanics in the reign of Naples, led to the conclusion that the most presumable possibility is Antonio Stelliola. Yet, also Giacomo della Porta is not to be excluded. For further informations on mechanics in the Reign of Naples in the decades around 1600, cf. R. Gatto, *La Meccanica a Napoli ai tempi di Galileo*, Napoli, La città del Sole, 1996.

[2]Cf. BOP, ms 426, fol. 149 r/v: "Ho avuto carissimo che abbiate dato il mio libro a quel valent'uomo che (sicome V.S. dice benissimo) laudand'egli le cose del Comandino è forza che sia tale. Che'l laudi poi il mio libro, questo l'attribuisco a creanza e non al merito. Avrò caro se parlarete seco che gli domandate quel che gli pare di quella *opinion nuova* che è nel primo trattato *De Libra*, quella dico che non voleva consentire Silvio Belli." The emphasis is ours.

[3]There is no doubt, that the "new opinion" meant the indifferent equilibrium: in the chapter *De Libra* there is no other substantial novelty. Further, Guidobaldo himself calls it "nuova opinione dimostrata nella detta quarta proposizione" in his letter to Pigafetta, 2nd of April 1581, cf. I.4.1.

[4]For a biography of Silvio Belli, cf. A. Fiocca, *Silvio Belli ingegnere: empiria e matematica nella cultura tecnica del Rinascimento*, cit. Interestingly in regard, Belli was in contact both with Pigafetta and Pinelli. The circle around Gian Vincenzo Pinelli was familiar with the *Mechanicorum Liber*, as Guidobaldo had sent a copy to this scholar on October 6th 1577, at Cesare Benedetti's instance (cf. BAM, ms. J 231 inf., fol. 194v).

[5]For Guidobaldo's correspondence this means an absolute peak. The real number presumably was even higher, considering that only an exiguous part of Guidobaldo's correspondence

have survived from a nine months' period nine months between Guidobaldo on the one side and Pigafetta and Contarini on the other about topics relative to his writing. So, on October 9th 1580 he wrote to Contarini:[1]

> (...) Your Lordship invites me to say my opinion regarding <material> experiences and <mathematical> demonstrations. Talking shortly on them, you have to know that, before I have written anything about the *Mechanicorum Liber*, I did never want to determine (in order not to commit an error) anything, as little as it was, if I had not first effectively seen that the experience corresponded with the demonstration; and I have made the experience of every smallest thing.
>
> So, I have also made a balance with the rotation point in its middle which shows most truly that, brought in an arbitrary position, it remains at rest where it is left, as the fourth proposition *De Libra* in the *Mechanicorum Liber* states; this is something that bothers many scholars which were not able to fabricate it.
>
> Anyway, it is most certain that practice and theory coincide always, and do not differ from each other. And further, I say you that the demonstrations have taught me quite a lot about how to make the experiences, about which it is worth to consider many things: first, the instruments should be rather little than large; as for example the pulleys with their wheel which should be made, if possible, of brass with very thin axes; the wheels should be turned well so that the do not waggle around the axes, but turn with just a blow if possible, this would be very good.[2]

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has survived.

[1] Cf. BNMV, ms. It. IV, 63 Ven. 259; published in A. Favaro, *Due lettere inedite di Guidobaldo del Monte a Giacomo Contarini*, in "Atti del Reale Istituto Veneto di scienze, lettere ed arti", LIX 2 (1899-1900), pp. 307-310. It is transcribed in Appendix I, I.8.2.

[2] "V.S. Ill.ma m'invita a voler dir il mio parere circa la esperienza e la dimostratione. Sopra le quali discorrendo brevemente La deve sapere che prima che io abbia scritto cosa alcuna sopra le *Mechaniche* <i.e. the *Mechanicorum Liber*>, mai (per non far errore) ho voluto determinar cosa alcuna per minima che ella sia, se prima io non vedeva con effetto che la esperienza si confrontasse apunto con la demostratione, e di ogni minima cosa ne ho fatto la sua esperienza. Dove ho anco fatto una libra la quale mi mostra verissimamente che avendo il centro nel mezzo di essa, mossa la libra dove si vuole, sta ferma dove si lascia, come dice la quarta proposizione <del capitolo> *De Libra* nel mio libro delle *Mechaniche*, che è cosa che dà fastidio a molti che non l'hanno saputa far materialmente. Insomma questa è cosa sicurissima che la pratica con la theorica vanno sempre insieme, né si discostano punto l'una dall'altra. Et di più Le dico che la dimostratione mi ha insegnato assai come si hanno da far l'esperienze, sopra le quali per chiarirsi bene bisogna considerar molte cose: primo che gli instrumenti siano piccoli più presto che grandi; come per essempio le taglie con le sue girelle, che se fusse possibile di farle di ottone con li sui assi di ferro sottili sottili; et che le girelle siano benissimo tornite, le quali non balassero attorn'agli assi, ma però che girassero con un soffio se fosse possibile, questo sarebbe benissimo."

In advance, Contarini had discussed with Giulio Savorgnan about the interplay between mathematical demonstration and material experience;[1] subsequently, they had asked Guidobaldo about his opinion in regard. They seem to have been interested especially in two subjects: pulleys and, exactly, the isostatic balance. Guidobaldo claims to have built such a balance, and to have personally verified that his theory and the "material experience" coincided.[2] He emphasised that the results predicted by the theory cannot be achieved with ordinary, but only with precision machines, made with materials like brass that minimised the friction -[3] and this was valid for balances in general, and the isostatic balance in particular. Another interesting aspect is Guidobaldo's comment that the theory of indifferent equilibrium "bothers many scholars" - a clear hint that Silvio Belli has not been the only critic.

At a certain moment, however, Guidobaldo must have realised that the treatment of Proposition IV *De Libra* and the assurance to have constructed such a balance himself, were not sufficient to convince the sceptics.
So he began to send exemplars of isostatic balances to his interlocutors: on April 2nd 1581, he wrote to Pigafetta dictating a paragraph that he wished to have inserted in *Le Mechaniche*, in the context of the digression about the indifferent equilibrium. A passage of the letter reveals that he had sent an isostatic balance to Gian Vincenzo Pinelli:[4]

> Moreover, I <i.e. Pigafetta> don't want to conceal that also the experience shows this truth <of the indifferent equilibrium of the isostatic balance> clearly: in fact, I have seen at G.V. Pinelli's home a balance, sent by the author <i.e. Guidobaldo> personally to this Sir, which, sustained in its barycentre, stays at rest in every position where it is left, after having been moved in an arbitrary position.

The fact that Guidobaldo had supplied Pinelli with a balance is significant and probably constituted a strategic move: the home of the scholar was an important centre of the Paduan academic circle. Then, besides the exemplar of the balance

[1] This information is contained at the beginning of the letter, cf. Appendix I, I.8.2.

[2] As far as the question is concerned if Guidobaldo had first seen the effect of indifferent equilibrium on a real balance an then constructed an appropriate theory, or if he, vice versa, had first developed his theory and then tried to construct a real model of the isostatic balance: this letter can be interpreted as a confirmation of the second hypothesis. This seems to be in contrast to Palmieri's hypothesis, exposed in P. Palmieri, *Breaking the Circle. The Emergence of Archimedean Mechanics in the Late Renaissance*, in "Archive for History of Exact Sciences", LXII (2008), pp. 301-346.

[3] In regard, cf. also E. Gamba, *Guidobaldo dal Monte tecnologo*, in "Pesaro città e contà. Rivista della Società pesarese di studi storici", V (1995).

[4] Cf. BAM, fondo Pinelli, ms D34inf, fols. 117-119. The complete transcriptions of the letter and, juxtaposed, of the scholium inserted in *Le Mechaniche* are exposed in I.4.1.

at Pinelli's, Guidobaldo sent another exemplar to Pigafetta personally, as he letter of May 2nd 1581 between the two scholars:[1]

> Mand'a V.S. li compassi et la bilancia. (...) La bilancia sì che credo che Dio sa quel che La riuscirà, bisogna che V.S. l'attachi, perché non si può così tener saldo con la mano che basti poi quando La moverà la bilancia, bisogna avertir che la non pigli l'andar o in su o in giù, perché ogni minima cosa la fa muovere; et Dio voglia che nel portarla la non si muova. Io l'ho provata molte volte et sempre è stata dove la si è lasciata (...).

The request of this second balance might hint at some scepticism that had possible remained even in the Paduan environment around Guidobaldo's acquaintances and friends.

But Padua was not the only centre of mechanical studies to which Guidobaldo destined exemplars of the isostatic balance: he sent one even in Spain (!), against the following background: in 1598, Botwid of Närke, a Swedish Jesuit scholar residing in Madrid as member of the Madrid Academy of Mathematics, had approached his former teacher Clavius, criticising Guidobaldo's theory of the isostatic balance and asking his opinion.[2] The Marchigian mathematician, confronted with this umpteenth critique wrote a long letter trying to confute Botwid's arguments, but additionally decided to dispatch an exemplar of the isostatic balance to Madrid.
The following letter of September 21st 1599 was written in this context, from Guidobaldo to Pier Matteo Giordani:[3]

> And if the said Spanish count saw that this balance brings us honour and clears with the senses anyone who does not believe in this effect, he <Count of Carpegna> could leave it there in the hands of some gentleman, but not in <Botwid's>: so there would be this balance, able to convince everyone.

Guidobaldo's decision to send an isostatic balance even to Spain - it took a considerable effort to travel from Italy to Spain, in those times - symbolises his determination to confute the critiques concerning his theory of indifferent equilibrium.[4]

[1] Cf. BAM, D34 inf, fol. 139r. Letter from Guidobaldo to Pigafetta, May 2nd 1581.

[2] This debate will be topic of Part B, I.4.

[3] Cf. BOP, ms 426, fol. 176r. The entire letter is reported in I.4.4, which dwells on the whole debate.

[4] And given the extreme lacunarity of his correspondence it cannot be excluded that he sent his isostatic balances also elsewhere.

This behaviour of Guidobaldo resembles Galileo's, when the latter tried to convince his interlocutors in regard of his discoveries about the moon and the sky: he, too, sent exemplars of his *cannocchiali* to them. Analogously to the Marchigian mathematician in regard of the indifferent equilibrium, Galileo had maintained a position that was in sharp contrast to the dominating theory (in his case: the Aristotelian conception of the *cosmos*). After he had exposed his discoveries in the *Siderius Nuncius* (1610) and met a vehement hostility against his theory, he recurred to the method of arguing in favour of his theory, by sending his telescopes.[1]

Debates at Pesaro and Baldi's treatment of the topic in the *Exercitationes*

The critical reception of Guidobaldo's treatment of the isostatic balance resonated also in the scientific environment of Pesaro, generally characterised by its interest in mechanical questions.[2] There are especially two elements that testify this fact: on the one hand, the extant documents suggest the existence of a broad debate at Pesaro, between Guidobaldo's interlocutors, in occasion of Botwid's critique and the dispatch on the balance – they are exposed in I.4.4; on the other, also Baldi's *Exercitationes* are informative in regard: his first studies on the topic seem to date back exactly to the eighties when the debate about Guidobaldo's indifferent equilibrium was in full play.[3]

Baldi comes to speak about different balances in occasion of *Quaestio* II. After having dealt with the balances of stable and unstable equilibrium, Baldi introduces the successive section with the words:

> But it is very strange that a person of such intelligence has not approached in any way the balance which has the support neither above nor below, but exactly in his centre, in the way that its barycentre coincides with its support. Hence, we will treat this balance which is deserves attention and is useful for the subject with which we deal.[4]

[1]We would like to thank Prof. Napolitani for the suggestion of this parallelism between Guidobaldo and Galileo.

[2]For general information on this environment, cf. Part A, II. Specifically on the debates at Pesaro regarding Botwid's critique, cf. Part B, I.4.4.

[3]Cf. E. Nenci's introduction in B. Baldi, *In mechanica Aristotelis problemata*, ed./transl. E. Nenci, vols. 2, Milano, Angeli, 2010. Even if the question about the period of creation of this work is not entirely solved, it seems probable that it has to be dated in the first half of the eighties.

[4]Cf. B. Baldi, *Exercitationes*, p. 32: "Id autem valde mirum, hominem acutissimum nihil prorsus de ea libra egisse, quae fulcimentum nec sursum habet, nec deorsum, sed in ipso exquisite medio, ita ut centrum gravitatis in ipsomet fulcimento consistat. Nos igitur de hac quod operae pretium fuerit, et ad rem, qua de agimus utile, in medium proferemus."

Treating then the isostatic balance, it does not astonish that he agrees with his teacher's theory predicting the persistence of the isostatic balance in an inclined position. Interestingly, he even repeats Guidobaldo's critique against the contrasting theories:

> This problem has been approached in an incorrect way by some modern authors, like Gerolamo Cardano, Niccolò Tartaglia and some others who followed the assertions of Jordanus Nemorarius; the latter's demonstrations, or rather paralogisms, have been excellently confuted by Guidobaldo in the fourth proposition of the chapter *De Libra* of the *Mechanicorum Liber* to whose splendid writing we refer the reader. There, he deals in a very detailed and complete way with this topic. We, in contrast, will explain only with few words the elements that suffice to know about the argument.[1]

I.4 Aftereffects of the topic in Guidobaldo's work

The precedent section has evidenced Guidobaldo tried to convince the critics of his theory of the isostatic balance - by explaining again and again its theoretical foundations in letters, and by sending models of the isostatic balance to his interlocutors - not only to Padua, but also in Spain (and who knows where else). Yet, this was not the only strategy he pursued - he might have realised, that even his 50-pages-exposition in the *Mechanicorum Liber* (cf. I.2) had not been enough to confute his critics' arguments and convince his sceptics. The present section deals with Guidobaldo's various ways of making propaganda for his theory.

I.4.1 The scholium in *Le Mechaniche*

Pigafetta's vulgar translation of the *Mechanicorum Liber* offered the occasion for Guidobaldo's first "public" countermeasure: he made him insert a lengthy comment on the indifferent equilibrium, emphasising the importance of the treatment of the isostatic balance and hinting at the existence of real models of the isostatic balance - this element had been absent in the *Mechanicorum Liber*.
In the following columns we present on one side Guidobaldo's letter of the 2nd of April 1581,[2] and on the other Pigafetta's version published in *Le Mechaniche*

[1] Cf. B. Baldi, *Exercitationes*, p. 32: "Quaestionem hanc perperam tractarunt recentiores quidam, Hieronimus Cardanus, Nicolaus Tartalea, et alii nonnulli, qui Iordani Nemorarii assertiones sunt secuti, quorum demonstrationes vel paralogismos potius egregie confutavit in *Libro Mechanicorum* tractatu *De Libra* prop. 4 Guidus Ubaldus ad cuius probatissima scripta Lectorem ablegamus. Fusissime enim ibi hac de re et absolutissime agit. Nos autem quidem paucis ea, quae ad hanc cognitionem pertinent, explicabimus. (...) "

[2] Cf. BAM, fondo Pinelli, ms. D34 inf, fols. 117r-119v; published by G. Micheli, *Guidobaldo del Monte e la meccanica*, in L. Conti (ed.), *La matematizzazione dell'universo. Momenti della cultura matematica tra '500 e '600*, Assisi, Porziuncola, 1992.

(fols. 28v-29r). This juxtaposition illustrates that Pigafetta adopts almost textually Guidobaldo's version.

BAM, fondo Pinelli, ms. D 34 inf, fols. 117-119

Molto Mag.co et Ecc.te S.r mio
Per la sua vedo che V.S. ha troppa fidanza in me poiché non vuole fare cos'alcuna se La non me n'avvisa. Ma lasciando queste cose, io circa il titolo del libro mi riporto a quello che V.S. giudicarà che sia meglio; è ben vero ch'a me ancora piace assai *Le Mechanice del*, etc.
Circa il voler far uno scolio sopra le cose della bilancia, non mi dispiace, e però io lo metterei a carte 5b doppo il nesso 2b che dice "eodem proporsus modo considerare poterimus".

E potria dir che qui non è da tralasciar di dir che l'autore è stato il primo a considerar exquisitamente la bilancia et considerarla dalla sua vera natura et essentia (per dir così), essendo egli stato il primo ch'abbi manifestato chiaramente il modo di trattarla. Considerando egli per questa speculatione tre centri:
Cioè il centro del mondo, il centro della bilancia, et il centro della gravità della bilancia, che in essa era com'un segreto di natura, senza li quali centri è cosa manifesta, che non si può venir in cognition perfetta, et dimostrar i varii suoi effetti li quali nascono dalla diversità di collocare il centro della bilancia in tre modi, cioè o quando il centro della bilancia è di sopra al centro della gravità di essa, overo quando è di sotto, overo quando il centro del-

Le Mechaniche, scholium, fols. 28v/29r

In questo luogo egli conviene avertire, il che potevasi anco fare di sopra a carte cinque presso la fine della seconda faccia ove è scritto "oltre a ciò possiamo considerare le cose che seguono in tutto al modo istesso."
Che questo autore è stato il primo a considerare esquisitamente la bilancia, et intenderla dalla natura, et dal vero esser suo; peroché egli il primiero di tutti ha manifestato chiaramente il modo del trattarla et insegnarla, con proporre tre centri da essere considerati in questa speculatione:

L'uno è il centro del mondo, l'altro il centro della bilancia, et il terzo il centro della gravezza della bilancia, che in essa era un nascosto secreto di natura. Senza questi tre centri, chiara cosa è che non si puoté venire in conoscimento perfetto, ne dimostrare gli effetti varii della bilancia, i quali nascono dalla diversità del collocare il centro della bilancia in tre modi, cioè quando il centro della bilancia sta sopra il centro della gravezza di essa, overo quan-

la bilancia è nel centro della gravità di essa, siccome egli mostra nelle tre precedenti propositioni:

nella prima delle quali mostra quando la bilancia torna sempre equalmente distante dall'orizonte, nella seconda mostra quando non solo non ritorna ma si move al contrario, nella terza che viene a essere la prossima quarta propositione, mostra ch'essendo ella sostenuta nel suo centro della gravezza sta ferma dove ella si ritrova, la qual cosa in particolar non è stata più tocca né manifestata da nessuno, anzi finora da tutti li antecessori tenuta impossibile et falsa.
Li quali non solo con molte ragioni si sono sforzati di provar il contrario, ma hanno anche affirmativamente detto che l'esperienza mostra ch'ella non sta mai ferma se non quando la bilancia è egualmente distante dall'orizonte, cosa al tutto repugnante, prima alla ragione, essendo la dimostratione di questa quarta propositione tanto chiara, facile et dimostrativa, che non so come se gli possa in mod'alcuno contradire.

Poi non voglio restar di dir che l'esperienza ancora mostra questa verità manifestamente, avend'io veduto in casa del signor Gio. Vincenzo Pinello una bilancia mandata dall'istess'autore a quel signore, la quale per esser sostenuta nel centro della sua gravezza, mossa dove si vuole e poi lasciata, sta ferma in ogni sito dove ella si lascia.

do è di sotto, o pure allorché il centro della bilancia è nell'istesso centro della gravezza di lei; si come l'autore insegna nella tre precedenti dimostrationi, cioè nella seconda, nella terza, et nella quarta propositione:
peroché nella seconda mostra quando la bilancia torna sempre egualmente distante dall'orizonte; nella terza quando non solo non ritorna, ma si move al contrario; nella quarta, che essendo la bilancia sostenuta nel suo centro dalla gravezza sta ferma dovunque ella si trova, il quale effetto in particolare non è piu stato tocco, ne veduto, ne manco da niuno manifestato fuorché dall'autore: anzi fin hora tenuto falso, et impossibile da tutti gli predecessori nostri.
I quali con molte ragioni si sono sforzati di provare non solamente il contrario, ma hanno etiandio affermato per certo, che la sperienza mostra la bilancia non dimorare già mai ferma se non quando ella è egualmente distante dall'orizonte. Laqual cosa in tutto è contraria alla ragione prima, per essere la dimostratione della sudetta quarta propositione tanto chiara, facile, et vera, che non so, come se le possa in modo alcuno contradire. Et poi all'esperienza: concio sia che l'autore abbia fatto sottilissimamente lavorare bilancie giuste a posta per chiarire questa verità, una delle quali ho io veduto in mano dell'Illustre Signor Gio. Vicenzo Pinello, mandatagli dall'istesso autore, la quale per essere sostenuta nel centro della sua gravezza, mossa dovunque si vuole et poi lasciata, sta ferma in ogni sito dove ella vien lasciata.

È ben vero che non bisogna correr a furia a far quest'esperienza, per esser cosa molto diffcile (come dice l'autor più a basso) a far una bilancia la qual sia sostenuta nel suo proprio centro della gravità. E però è d'avvertir che quando alcuno si mettesse a far questa esperienza e non gli riuscisse, dica pur risolutamente di non aver fatto bene, e torni a far di nuovo l'esperienza finché la bilancia venghi sostenuta nel centro preciso della gravità.

E se ben da altri sono state tocche le altre duo speculationi, cioè quando la bilancia torna sempre egualmente distante dall'orizonte, et quando si muove al contrario da questo sito, nondimeno non si è mai saputa questa verità manifestamente se non da questo autore. Perché gli altri non hanno saputo questa distintione di considerar in tre modi il centro della bilancia come habbiamo detto, e però se hanno detto alcuna cosa sopra ciò, l'hanno detta confusissimamente et con male dimostrazioni dalle quali non se ne poteva cavar risolution ferma e chiara.

Li quali antecessori si hanno da intendere li nostri passati moderni, fra li quali è stato Giordano che ha scritto De ponderibus , il quale fin qui è stato molto seguitato essendone stato tenuto grandissimo conto. Et questo lo dico perché si vede che l'autor ha cerco con ogni studio di seguitar la dottrina degl'antichi greci, padri e maestri delle scienze, in particolar del Prencipe

Ben è egli vero che non bisogna, nel fare cotesta esperienza, correr così a furia, per essere cosa oltra modo difficile, come dice l'autore di sopra, il fare una bilancia, la quale sia nel mezo delle sue braccia sostenuta a punto, et nel centro proprio della sua gravezza. Per la qual cosa egli è da por mente che qualora alcuno si mettesse a far cotale esperienza, et non gli riuscisse, non perciò si deve sgomentare, anzi dica pur fermamente di non haver bene operato et un'altra volta ritorni a farne la sperienza, finché la bilancia sia giusta et eguale, et venga sostenuta a punto nel centro della gravezza sua.

Et benché da altri siano state tocche le altre due predette speculationi, cioè quando la bilancia ritorna sempre egualmente distante dall'orizonte, et quando si move al contrario di questo sito, tuttavia non si è piu intesa questa verità gia mai apertamente, se non dall'autore nostro; peroché gli altri non hanno col senno penetrato in ciò tanto avanti, che habbiano saputo con distintione considerare il centro della bilancia in tre modi, come ho narrato. Che se hanno pur divisato qualche cosa d'intorno a questo, l'hanno fatto confusissimamente, et con male dimostrationi dalle quali non si puotè cavare ferma conchiusione et chiara.

Questi predecessori nostri han si da intendere i moderni scrittori di cotal materia allegati in diversi luoghi dall'autore, fra quali Giordano, che scrisse de' pesi, fu riputato assai, et sin qui è stato seguito molto nella sua dottrina. Or' l'autore nostro ha procurato con ogni studio di caminare per la via de' buoni Greci antichi, maestri delle scienze, et in particolare di Archimede

delle scienze mathematiche, Archimede famosissimo, et di Pappo Alessandrino.

Ma acciocché questa sua nuova opinione dimostrata nella detta quarta proposizione resti al tutto chiara, non si è contentato di averla dimostrata con vive ragioni, ma come scientifico (imitandola Aristotele il quale nei principii dei suoi libri, volendo trovar miglior scienza, ha sempre dato contra l'opinione de gli antichi confutando le loro ragioni) ha voluto (essendo la verità una) scioglier le ragioni degl'altri, che par che provino il contrario, mostrando la loro fallacia, facendo questa digressione che seguita che in questa materia servirà (come si suol dire) per l'opinion degl'antichi.

La quale deve esser letta e considerata diligentemente: essendo in essa cose di gran speculationi, massime intorno alla consideratione dove sia più grave un peso solo, posto in un braccio della bilancia, essendo egli non solo stato il primo che abbi trovata questa verità, ma il primo ancora ch'abbi mostrato in che modo bisogni considerar e specular questa materia.

Siracusano Prencipe delle mathematiche famosissimo, et di Pappo Alessandrino, come egli dice, leggendogli nella sua propria favella, non tradotti; peroché il più delle volte sono così mal trattati, che a gran pena si puotè trarre da loro frutto veruno.

Et affineché questa nova opinion sua, dimostrata a pieno nella predetta quarta propositione, resti totalmente chiara, non si è gia contentato egli d'averla dimostrata con vive ragioni et certe solamente. Ma come buon filosofo, procedente con via di reale dottrina et di fondata scienza (imitando Aristotele, il qual ne' principii de suoi libri, investigando dottrina migliore, ha datto contra la opinione de gli antichi, solvendo le ragioni addotte da loro) ha ben voluto, essendo la verità una sola, proporre le opinioni de' suoi predecessori, et esaminare le loro ragioni le quali sembrano provar il contrario, et solverle, la loro fallenza dimostrando col presente discorso, che incomincia, come è detto, a carte cinque nella faccia seconda et qui finisce. Il quale discorso servirà in questa materia, secondo che si suole dire per la opinione degli antichi.

Et perciò che egli contiene cose di altissima speculatione, massimamente d'intorno al considerare dove sia più grave un peso solo posto in uno braccio della bilancia. Bisogna in ogni modo, per bene intendere, leggerlo et istudiarlo con accuratissima diligenza. Ma per certo l'autore è stato non solo il primo a trovare questa verità, ma il primo etiandio a dimostrare in qual maniera sia mestieri considerare et speculare interamente la presente materia tutta.

Con la quale speculation prova e conferma di nuovo i varii effetti della bilancia già mostrati di sopra nelle prossime tre propositioni, mostrando ancora come fin qui queste cose siano da gl'altri state considerate malamente e con principii falsi. Anzi di più per maggior confirmatione della verità, mostra che questi tali non hanno saputo far le loro dimostrationi, poiché con il lor modo di specolar e con le loro ragioni ancora prova la sua intenzione esser vera.

Mostrando anche come gli sia d'accordo con Aristotele nelle *Questioni Mechanichae* dove che trattando queste cose, move alcuni dubii circa tal materia molto belli, li quali ha chiaramente soluti in ultimo, poi brevemente ha trattato delle bilancie che hanno li bracci disuguali, et di quelle che hanno li bracci piegati e storti. Et insomma si pò dir che in questa digressione sia rincchiuso tutto quello che si pò dir circa tal materia. Le quali cose sono tutte di bellissima et sottilissima speculatione, et a chi attende et si diletta di questo studii sono cose necessarissime, et da esser con molta attentione lette et considerate.

Et questo è quanto per ora Gli posso dir intorno al scolio (...). mi è parso bene di dir che V.S. abbi visto quella bilancia in casa del Signor Pinello, acciò la gente non si credesse che quella fusse una chimera, e che la non si

Con la quale speculatione prova di novo, et conferma i varii effetti et accidenti della bilancia già dimostrati nelle prossime tre propositioni; mostrando ancora, come sin qui coteste cose siano dagli altri state malamente considerate, et con principii falsi. Anzi di più per confermatione della verità soggiunge, che questi tali non hanno saputo fare le loro demostrationi; poiché col proprio modo di speculare usato da loro, et con le loro medesime ragioni prova la sua intentione et sentenza essere verissima;
Appoggiandosi alla dottrina di Aristotele sempre, et facendo toccar con mano, che egli con esso lui è d'accordo nelle *Questioni Mechaniche*. In trattando questa materia move l'autore alcuni dubbi molto belli, et curiosi, et poi chiaramente gli solve. In ultimo, accioché non mancasse nulla al compiuto conoscimento di questo soggetto, egli ha trattato delle bilancie, che hanno le braccia disuguali et di quelle che hanno le dette braccia piegate et torte. Insomma si può ben affermare che in cotesto discorso siano comprese tutte quelle cose, che possono essere divisate d'intorno a materia tale. Le quali sono di bellissima et sottilissima speculatione, et a chiunque si diletta et attende a questi nobili studi necessarissime, et da essere, come ho ricordato più d'una volta, con molta attentione vedute et considerate.

Dove si legge questo vocabolo latino *equilibrio*, intendasi per eguale contrapeso, cioè che pesa tanto da una banda, quanto dall'altra in pari lance o libra o bilancia che si dica. "Librar con giuste lance" disse il Petrarcha.

potesse fare né mettere in atto. E se per sorte quella bilancia che mandai al Signor Pinello fusse guasta, io mi obbligo a manadrne una a V.S. ogni volta ch'Ella vuole. Non volgio esser più lungo per non La fastidir più, e Gli bascio le mani. Di Pesaro alli 2 di aprile del 1581.
Di V.S.,
Guidobaldo de' Marchesi del Monte.

As the comparison of the two columns shows, Pigafetta adopts what Guidobaldo had dictated, with slight modifications regarding the wording. The latter, on his part, had insisted mainly on the following points:
Firstly, he underlines his primacy in having correctly described the balance, according to "its *true* nature". This would have been possible by distinguishing and considering the three points *centro della bilancia* (i.e. the rotation centre), the *centre of gravity* of the balance-system, and the centre of the world. This approach would have permitted him to explain the behaviour of the isostatic balance correctly – until his days, the phenomenon of its perseverance in the inclined position would have been considered as wrong and impossible "by all the predecessors".
Yet, their believe would be absurd for two reasons: in the first place, the demonstration of Proposition IV *De Libra* would be so clear that it could not be contradicted; and on the other hand, there would be really existing exemplars of the isostatic balance manifesting what his treatment had predicted mathematically. So, if anybody would not succeed in imitating this result, he should not cease trying, since the theory would be true, but the isostatic balance difficult to produce. Obviously, among the predecessors holding the wrong opinion about this topic there would be Jordanus and his followers, but not Archimedes and Pappus whose theory he had tried to follow.
Now, in order to evidence Jordanus's errors, he would have attempted to dismantle the medieval scholar's and his followers' arguments, according to the model adopted by Aristotle – in his capacity of "*scientifico*", it would be his commitment to do so.
The entire proposition should be read diligently, as it would contain argumentations of great subtlety, in particular the considerations where a weight on a rotatable balance arm is to be regarded as positionally heaviest. With analogous argumentations he would prove also the results of the three first propositions. Finally, he would also highlight that his theory is in accordance with Aristotle's, exposed in the *Quaestiones Mechanicae*.

The antecedent scholium testifies that *Le Mechaniche* offered Guidobaldo the possibility to add modifications and clarifications to the *Mechanicorum Liber*, and constituted so a kind of second, revised version. Besides the integration of Pappus's treatment of the inclined plane, the foregoing scholium on the indifferent equilibrium is the most substantial intervention in the work.
All in all, this addition can be regarded as Guidobaldo's *first* "public" reaction against the continued critiques in regard of the indifferent equilibrium.

I.4.2 Against Benedetti - Guidobaldo's marginal notes in the *Diversarum Speculationum Liber* and the respective entries in the *Meditatiunculae*

As seen before, Benedetti had exposed an own, innovative theory of the balance in his *Diversarum Speculationum Liber* (1585) that could not have pleased Guidobaldo: admittedly, Benedetti had criticised Tartaglia's and Jordanus's, but at the same time he had presented a treatment of the balance that contradicted Guidobaldo's: it predicted, instead of the manifestation of indifferent equilibrium, the movement of the inclined isostatic balance to the vertical position.[1]
Fortunately, Guidobaldo's original exemplar of the *Diversarum Speculationum Liber* has survived,[2] containing precious information about Guidobaldo's objections to Benedetti's theory. In particular, the marginal notes concerning *Caput* II and III are elaborated in the *Meditatiunculae*. For their evident connection with the topic of the indifferent equilibrium, these objections seem worth to be dealt with in detail in the present subsection.

The marginal notes in Guidobaldo's exemplar of the *Diversarum Speculationum Liber*[3]

Regrettably – misfortune in fortune – the book has been rebound and the original pages have been cut. So, parts of Guidobaldo's notes are lost - sometimes they can be reconstructed, sometimes their meaning remains dubious.
He wrote on the margin of *Caput* VII (cf. figure I.28):[4]

> He +supposed+ that the weights a, b do not move. +In+ this demonstration the weight a +is+ hea+vier+ than the weight b because

[1] For an overview of Benedetti's mechanical work, in particular of *De Mechanicis*, cf. Part A, III.5.

[2] The exemplar has recently been acquired by the Max-Planck-Institut für Wissenschaftsgeschichte, and can be consulted at http://echo.mpiwg-berlin.mpg.de/content.

[3] A description of Guidobaldo's marginal notes is contained in J. Renn, P. Damerow, *Guidobaldo's Marginal Notes on Benedetti's* Diversarum speculationum, cit.

[4] In the following transcription, we put the words, which are cut off but, in our opinion, reconstructible, between the signs + . + while the rest of the applied symbolism and transcription criteria remains the same (cf. Appendix I, pp. 415-416).

+their+ gravities are measured by the per+pendicul+ar lines *ot*, *oe* of which *ot* is bigger. It follows that the weight *a* is heavier in its place than *b* in its place. Thus, I say how will he avoid, that the +w+eight *a* does not move downwards and *b* upwards +on+ the balance. Therefore, *ab* will not stay at rest as he had supposed and as it really does: in fact, he wanted to +demonstra+te Jordanus's and Tartaglia's errors (whose reasons he does not confute, neither)[1]; he gets tangled up in equally serious (even if not in worse) absurdities. So it is obvious how useless and erroneous this consideration made about his perpendiculars <in *Caput* III> is. As (...) .[2]

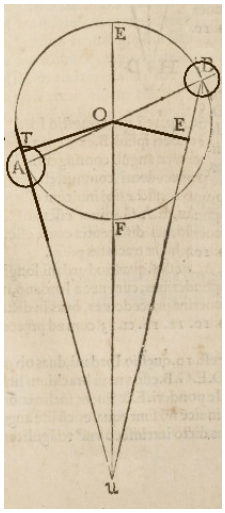

Figure I.28: The inclined isostatic balance in Benedetti with the projections OT and OE.

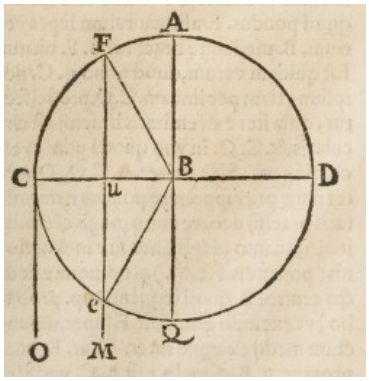

Figure I.29: The figure of the first two propositions in the *Diversarum speculationum Liber*.

So, summarising the substantial steps of Benedetti's demonstration, Guidobaldo correctly identifies *Caput* III as the working proposition of *Caput* VII's demonstration. His marginal comment to *Caput* III – for its implications it is advisable to have a glance to it – is been quite damaged by the rebinding. Yet, in our

[1]Here again appears Guidobaldo's idea that in a scientific debate the adversaries' arguments have to be confuted. This is the basic idea of the fourth proposition of the *Mechanicorum Liber* treating the indifferent equilibrium, cf. p. 279.

[2]Guidobaldo's marginal comment on *Caput* VII: "+suppos+uit pondera *a*, *b* non moveri. +In+ hac demonstratione pondus *a* gra+vius+ +e+st pondere *b* quia [horum] gravi+tates+ metiuntur lineae perpe+ndicula+[res] *ot*, *oe* quarum *ot* maior est. Sequitur pondus *a* in hoc situ gravius esse pondere *b* in hoc situ. Dico igitur quare subterfugiet, <p>ondus *a* deorsum non moveatur et *b* sursum? Libra ergo *ab* non manebit ut supposuit et ut re vera manet, +demonstra+re enim volens errores Jordani et Tartaleae (quorum etiam nec soluit rationes); incidit, et si non in peiora, tamen in aequalia +ab+surda. Unde perspicuum est quam sit inanis et falsa haec consideratio suis perpendicularibus facta. Quam .... "

opinion, the sense of the remaining words could be restored and summarised in the following way:

> On these two paragraphs all of the author's demonstrations are based. So, if we are certain about their falsity +also their consequences will be wrong+ (...) +the content of this third paragraph is wrong+ as becomes clear from *Caput* VII.[1]

In fact, this comment is in accordance with the marginal note of *Caput* VII. The next logical step then was to elaborate a mathematical demonstration of the non-validity of what Benedetti had exposed there. In fact, Guidobaldo dedicated two pages of the *Meditatiunculae* to this purpose, dealt with in the following paragraph.

Before their analysis, another aspect of Guidobaldo's comment seems remarkable: he deduced from Benedetti's erroneous result in respect of the isostatic balance the falsity of this idea of measuring the effective heaviness of weights/forces by the perpendicular projection: the indifferent equilibrium apparently served Guidobaldo also as a kind of "touchstone" for other scholars' mechanical theories - also in the *Mechanicorum Liber*, starting from the erroneous claims in respect of the indifferent equilibrium, brought forward by Jordanus and co., he highlights the intrinsic contradictions of central elements of the *Scientia de Ponderibus*.

The respective entries in the *Meditatiunculae*[2]

Guidobaldo's critique towards Benedetti in the *Meditatiunculae* refers (only) to *Caput* II and III of *De Mechanicis* and can be interpreted as detailed mathematical elaboration of the marginal notes in his exemplar of the *Diversarum Speculationum Liber*. As he had already remarked there, it is sufficient to confute the theory exposed in these two chapters, since they present and "demonstrate" the conceptual framework upon which Benedetti's further argumentation rests. In particular, as exposed above, *Caput* III directly furnishes the key concept with which Benedetti had contradicted Guidobaldo's solution for the isostatic balance.

Benedetti had stated in *Caput* II that the effective heaviness of a weight, fixed at the inclined arm of an angular balance, is measured by its vertical projection to the horizontal line. So, according to the Venetian scholar, any weight has the same "effect" if placed in F (on the balance arm FB), in u (on the balance arm

[1] Guidobaldo's mutilated marginal comment on *Caput* III: "In his duobus cap.<itis> fundantur omnes authoris demonstrationes, ita ut ... quorum cognita falsitate omnia ... (...) ipse ** in sequantibus inquit, hoc usque ** demonstratum quare nihil <concludit> ut patet in 7. cap."

[2] For a more detailed analysis of Guidobaldo's reasoning, cf. Part A, VI.2.1, subsubsection "*Against Benedetti's* Diversarum Speculationum Liber".

Bu) or in e (balance arm Be), while its counterweight remains invariant and fixed in D on the other balance arm BD (cf. figure I.30).

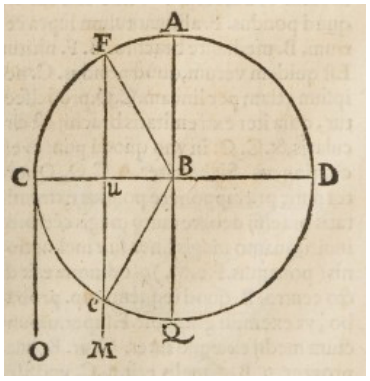

Figure I.30: The figure of Benedetti's second proposition.

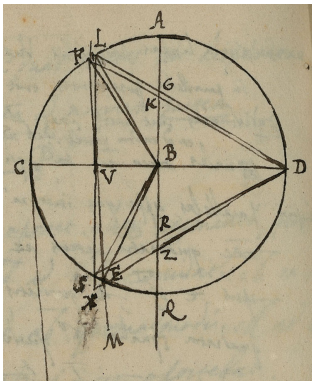

Figure I.31: Guidobaldo's figure on page 145 of the *Meditatiunculae*.

Page 145 of Guidobaldo's notebook, entitled "Contra Cap<ut> 2 Io<hanni> Benedect<i> de Mechan<icis>", attacks the validity of this statement by emphasising an incoherency of Benedetti's reasoning: in fact, the latter had characterised the line FuM as converging to the centre of the world. So, Guidobaldo really took Benedetti at his word - he was an expert of this procedure: already in the *Mechanicorum Liber* he had shown that Tartaglia's argumentation about the isostatic balance was wrong if converging lines of action were considered - and contrasted the inclined line FuM with the perpendicular AQ (cf. figure I.31). He proved that weights do have the same effective gravity, if located along the parallel AQ, i.e. in L, u and S. So, Guidobaldo's conclusion is exactly what Benedetti had claimed as well, only that the former avoids the later's incoherent consideration of FuM as sometimes vertical and sometimes converging.

Page 146, entitled "Contra Cap<ut> 3 eiusdem", deals with third chapter of *De Mechanicis*, presenting the fundamental working concept of Benedetti's treatise: how can the effect of forces or weights be measured which act along arbitrary directions? He claims that this is possible by considering the perpendiculars drawn from the centre of rotation of the respective mechanical device (balance, lever) to their lines of action. So, citing Benedetti's example, if a weight or force acts in c along ca, so its "effect" is measured by the perpendicular ot, where o is the rotation centre of the balance/lever boa (cf. figure I.32). If the same segment $oi = ot$ is applied to the actual beam oa, so the weight/force acting in c along ac has the same effect as if it were constituted in i with a perpendicular line of action.

Guidobaldo's argumentation confutes that the same weight in t, attached to the

angular balance/lever *bot*, has the same effective heaviness as in i, if attached to the straight balance/lever *boi* - ignoring, however, the fact that Benedetti had postulated different lines of action for the two cases. With this misinterpretation, it does not take much to evidence that bf and fd have the same relation as bo and oi, while bf and ft have not (cf. figure I.33). So, the same weight in d and i, but not in t, would counterbalance the weight e in b - obviously if the lines of actions of the weights in d and i are assumed to have the same direction, contrary to what Benedetti had presumed.

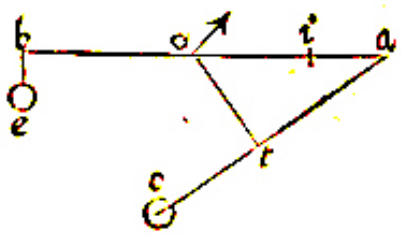

Figure I.32: The figure of the third propositions in *De Mechanicis*.

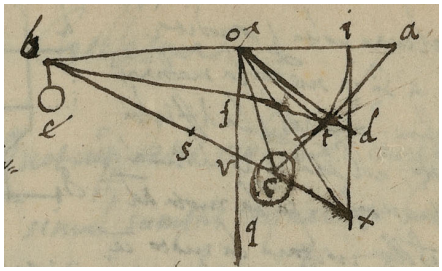

Figure I.33: Guidobaldo's respective figure on page 146 of the *Meditatiunculae*.

At the end of his reasoning, Guidobaldo concedes that Benedetti's reasoning might be true for the case of an applied "force", for example when a man pulls with a certain force c along tc. Yet, he emphasises that the statement cannot absolutely hold for the case of weights with converging lines of action, i.e. for the case of the inclines isostatic balance.

I.4.3 The *Paraphrasis* - the second public reaction

The defence of his theory of indifferent equilibrium constituted one of the purposes Guidobaldo had pursued by editing the *Paraphrasis*.[1] He dealt with the topic in various occasions in his writing of 1588, especially, but not exclusively, in the preface and in the scholium after the forth proposition.

Dedicatory letter and preface

The first hint at the topic can already be found in the first (!) phrase of the work, in the dedicatory letter: Guidobaldo complains that parts of his *Mechanicorum Liber* have been received as "totally new, almost unheard, and not sound enough

[1] For further information, cf. Part A, V.2.3.

(..) by a whole lot of scholars".[1] He declares that he has consequently approached the enterprise to expose Archimedes's theory, who would sustain and defend also Guidobaldo's own theory.[2] The hint at "unheard" theorems in the *Mechanicorum Liber* is clearly referring to the indifferent equilibrium.[3]

Then, in the preface, Guidobaldo dedicates a whole page (p. 10) to an argumentation that intends to justify Pappus's definition of *centre of gravity* - which was crucial in Guidobaldo's direct prove of the existence of indifferent equilibrium (cf. Part A, IV.2.2). In this context, it is advisable to keep in mind that the Archimedean definition of this key concept has not been transmitted. So Archimedes's followers in the Renaissance had to fill the notion with an exact meaning if they wanted to re-establish the validity of the entire theory. Even it the recourse to Pappus's definition seemed a rather immediate solution in this context, it had not nevertheless come down directly from Archimedes.[4] For this reason, and surely for the critiques he had received, Guidobaldo must have felt the exigency to explain the reasonableness of adopting the Pappian definition.
For that purpose, Guidobaldo has recourse to a theory of another major authority, namely of Aristotle himself, embedding the Archimedean mechanics – amplified by Pappus' definition – in the context of the cosmos of the Aristotelian conception: a heavy body is at rest in the centre of the world - this element of the Aristotelian natural philosophy is the basic assumption of Guidobaldo's following argumentation.[5] Thus, if a body is imagined in the centre of the world, all the parts of the body must be endowed with equal moments in respect of the

[1] *Paraphrasis*, p. i (not numbered): "Theoremata multa ac varia construxi (...), <qui> plerisque tamen, qui non admodum fortasse in huiusmodi rerum causis investigandis versati existunt, nova prorsus (ut accepi) ac ferme inaudita (...) visa sunt."

[2] *Paraphrasis*, p. i/ii (not numbered): "Quocirca cogitanti mihi, qua ratione fieri posset, ut opus illud a me editum, quam plurimorum sibi gratiam in dies magis conciliaret, in mentem venit, non aliunde id mihi opoertunius contingere potuisse, quam si priscos ipsos et gravissimos alioqui authores de hac re elegantissime disserentes illis offerrem.(...) mihi constitui, ex multis unicum tantum <testimonium> (...) deligere: qui et meam causam tueretur et illis, si fieri posset, satisfaceret."

[3] Surely, the indifferent equilibrium was not the only aspect contained in the *Mechanicorum Liber* that evoked scepticism: as we learn from Guidobaldo's correspondence with Contarini (cf. Appendix I, I.8.2): some scholars did not succeed in reproducing the proportions that Guidobaldo had predicted for the pulleys. This was probably connected with the fact, that Guidobaldo's (correct) theory was verifiable only with precision instruments, while Contarini, apparently, did not have such instruments at his disposal. Yet, the content of the *Paraphrasis* evidences that Guidobaldo did not refer to these theorems as "unheard": he does not prove nor hint at anything that would be even distantly related to this topic, whereas he comes several times times to speak about the indifferent equilibrium in the *Paraphrasis*.

[4] In fact, there were also followers of the Archimedean tradition that chose other approaches, like Francesco Maurolico. For a more detailed description of this situation, cf. Part B, II.3.

[5] *Paraphrasis*, p. 10: "Si grave quidpiam in centro mundi collocatum fuerit, oportere centrum gravitatis illius in centro mundi constitutum esse: siquidem ut grave illud tunc quiescat, partes undique ipsum ambientes aequalium momentorum existere, atque manere oporteat."

centre of the world (otherwise, one part would preponderate another and produce a movement of translation or rotation – in contradiction to the fact, that every heavy body is at rest in the centre of the world).[1] And this point is, according to Commandino's definition,[2] the centre of gravity. So, claiming that a body has a *propensio naturalis* to move to the centre of the world (according to Aristotle's natural philosophy), means in the end nothing else than that the body actually unifies his centre of gravity with the centre of the world.[3]
Now, since it is gravity that generates the movement of a heavy body towards the centre of the world (*propensio naturalis*), and since, in effect, it is the barycentre of the body that really coincides with the centre of the world (if there are no obstacles), so a body can said to actually weigh in its centre of gravity.[4] Once this is accepted, it necessarily follows that a weight held in its centre of gravity has to stay at rest immediately, as the "cause" of its movement – i.e. gravity itself – does not operate any longer.[5] So far Guidobaldo's reasoning.

The reference to the indifferent equilibrium is evident: if the isostatic balance (with two equal weights fixed in equal distances from the centre of rotation) is interpreted as an *unique* body, sustained in its barycentre (contemporaneously the centre of rotation), it has to stand still and does not move.
Even in other passages of the preface, Guidobaldo turns to the question if a body in equilibrium must necessarily be equidistant from the horizon – he obviously negates this question.[6]

[1] *Paraphrasis*, p. 10: "Siquidem ut grave illud tunc quiescat partes undique ipsum ambientes aequalium momentorum existere, atque manere oporteat."

[2] Guidobaldo reports Commandino's definition of *centre of gravity* on p. 10, shortly before the argumentation we are considering now: "Centrum gravitatis uniuscuiusque solidae figurae est punctum illud intra positum, circa quo undique partes aequalium momentorum consistunt. Si enim per tale centrum ducatur planum figuram quomodocunque secans, semper in partes aequeponderantes ipsam dividet."

[3] *Paraphrasis*, p. 10: "Quare dum asseritur, grave quodcumque naturali propensione sedem in mundi centro appetere, nil aliud significatur, quam quod eiusmodi grave proprium centrum gravitatis cum centro universi coaptare expetit, ut optime quiescere valeat."

[4] *Paraphrasis*, p. 10: "Ita ut tota vis, gravitasque ponderis in ipso gravitatis centro coacervata, collectaque esse, ac tanquam in ipsum undique fluere videatur. Nam ob gravitatem pondus in centrum universi naturaliter pervenire cupit, centrum vero gravitatis (ex dictis) est id, quod proprie in centrum mundi tendit, in centro igitur gravitatis pondus proprie gravitat."

[5] *Paraphrasis*, p. 10: "Praeterea quando aliquod pondus ab aliqua potentia in centro gravitatis sustinetur, tunc pondus statim manet, totaque ipsius ponderis gravitas sensu percipitur."

[6] *Paraphrasis*, p. 15: "Quandoquidem centrum gravitatis talis est naturae, ut si mente conscipiamus, rem aliquam in eius centro gravitatis appensam esse, eo prorsus modo, quo reperitur, quiescat et maneat." And cf. *Paraphrasis*, p. 16 "Sed ulterius adhuc progrediamur, dicamusque, quoniam planum ACD, quatenus est corpori coniunctum, horizonti aequidistans permanere debet; si seorsum a corpore illud intelligamus, ut si ADC ex sius centro gravitatis G suspendatur, tunc quocunque modo repetiatur, hoc est sive horizonti aequidistans, sive minus, idipsum permansurum nihilominus intelligere possumus, partesque undique aequalium momentorum consistentes."

Then, on pages 18-19 Guidobaldo reaffirms his critique versus Jordanus and Tartaglia, already brought forward eleven years before in the *Mechanicorum Liber*. In contrast, as Guidobaldo continues in the immediately following phrase, the scholars of mechanics ought to take Archimedes as model, instead of following the bad example of Jordanus and Tartaglia:

> And although Jordanus Nemorarius (followed by Niccolò Tartaglia and others) has tried to demonstrate also <the law of the lever> in his book on weights[1] and although he has used various means to show it, none of the attempts deserves the designation of "demonstration". In fact, he compounded his argumentations hardly by demonstrable arguments, but by elements that in no way seem necessary, and maybe by no demonstrable arguments at all. Since in mathematics most precise demonstrations are required, that Jordanus seems, in my eyes, not to be worth to be regarded as a scholar of mechanics. Therefore, we have to approach Archimedes, if we want to soundly learn the foundations of mechanics and the *true* principles of this science: in my opinion, he has cared mainly about this to hand down the elements of mechanics, as also Pappus holds in the eighth book of the *Collectiones Mathematicae*.[2]

This direct confrontation of Jordanus/Tartaglia on the one side and Archimedes on the other is noteworthy: the use of the wording "the *true* principles" can certainly be understood as a repeated critique of the *gravitas secundum situm-*

[1] It is not clear, if Guidobaldo refers to *De Ponderibus*, or to *De Ponderositate* – the wording "de ponderibus" is not explicitly cited as title of a book. Surely, he possessed the former one: I have found Guidobaldo's personal exemplar of Jordanus's *De Ponderibus* (edited by Apian), which reports several marginal notes of the Marchigian mathematician. I have indicated this discovery to the staff of the Max-Planck-Institut für Wissenschaftsgeschichte (Berlin), who have recently published it in J. Renn, P. Damerow, *The Equilibrium Controversy. Guidobaldo del Monte's Critical Notes on the Mechanics of Jordanus and Benedetti and their Historical and Conceptual Background*, Berlin, Editions Open Access, 2012. In a forthcoming study, I will present an in-depth analysis of Guidobaldo's notes and the context of this important critique against Jordanus's mechanics.

[2] *Paraphrasis*, pp. 18-19: "Et quamvis Iordanus Nemorarius (quem secutus est Nicolaus Tartalea et alii) in libello de ponderibus hanc eadem propositionem quoque demonstrare conatus sit; et ad eam ostendendam pluribus mediis fuerit usus, nulli tamen probationi demonstrationis nomen convenire potest; cum vix ex probabilibus, et iis, quae nullo modo necessitatem afferunt, et fortasse neque ex probabilibus suas componat rationes; cum in mathematicis demonstrationes requirantur exquisitissimae, ac propterea neque inter Mechanicos videtur mihi Iordanus ille esse recensendus. Quapropter ad Archimedem confugiendum est, si fundamenta mechanica, *veraque* huius scientiae principia perdiscere cupimus: qui (meo iudicio) ad hoc potissimum respexit, ut elementa mechanica traderet, ut etiam Pappus in octavo *Mathematicarum Collectionum* libro sentit." The emphasis is ours.

theory,[1] against which Guidobaldo tries to establish Archimedes's mechanics based on the concept *centre of gravity*.
Now, Guidobaldo obviously referred here not only to the indifferent equilibrium: he sided with the Archimedean theory also for its mathematically superiority and the argumentative clearness. Yet, he criticised the very *principia* of Jordanus's mechanics, as the passage above testifies. He becomes even more explicit in the comments of his exemplar of Jordanus's *De Ponderibus*:[2] on the margin besides the (erroneous) Proposition VII on the angular balance, which has recourse to the *gravitas secundum situm*) he writes:

> Wrong! On the contrary, the opposite follows if the demonstration would be made by *true* principles.[3]

Interestingly, also Baldi agrees with this conviction: in his *Cronica*, he writes in regard of Jordanus:

> (...) in his mechanics, he mad false assumptions, as the most learned Guidobaldo de' Marchesi del Monte shows.[4]

Guidobaldo's certainty about the falsity of Jordanus's "*principia*" derives exactly from his digression in the *Mechanicorum Liber* about the existence of the indifferent equilibrium and the confutation of central statements of the *Scientia de Ponderibus* in this context.

The scholium after Proposition IV

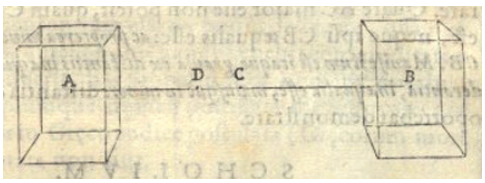

Figure I.34: The fourth proposition of the *Paraphrasis*.

Guidobaldo turns to this topic after the fourth proposition of the *Paraphrasis*: it deals with the position of the barycentre of a magnitude composed by two

[1] Guidobaldo had shown in the fourth proposition of his *Mechanicorum Liber*, that this theory contains many intrinsic contradiction and led, moreover, to erroneous results regarding the isostatic balance, cf. Part A, IV.2.2.

[2] For further information, cf. Appendix I, **??**.

[3] "Falsa; immo sequitur oppositum si per principia *vera* fiat demonstratio." The emphasis is ours.

[4] Ebbe dottrina assai barbara, e nelle Mecaniche prese assunti falsi, come nelle *Mecaniche* sue mostra il dottissimo Guidobaldo de' Marchesi del Monte.[5]

initial, equal magnitudes (cf. figure I.34). It is the first theorem in the Syracusan's treatise using the concept *centre of gravity*.[1] So, it offered Guidobaldo the possibility to dwell on some properties of this notion and he correspondingly used the occasion of the respective scholium to a digression of more than seven pages – the lengthiest scholium in the *Paraphrasis*.

First, he attends to the problem why the balance with two weights can be considered as a unique body. This is a crucial element both for Archimedes's and Guidobaldo's own mechanics: the former had recourse to this idea *inter alia* in the demonstration of the law of the lever, the latter used it for the demonstration of the existence of indifferent equilibrium.
As Guidobaldo explains, at the beginning the two separate magnitudes certainly are autonomous and have to be considered singularly. Yet, the conjunction between the weights would not only have the effect that it connects the two magnitudes, so that they cannot any more approach or recede each to/from each. But it transmutes the two weights in a new, unique physical identity:

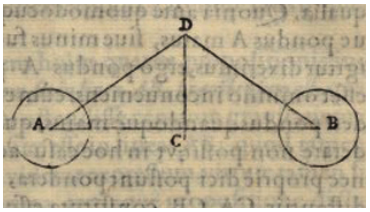

Figure I.35: The equivalence of the concepts *equiponderation* and *centre of gravity* does not hold for this kind of balances, for example.

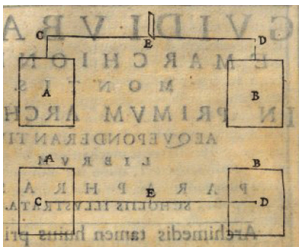

Figure I.36: Guidobaldo argues, after the first postulate, that Archimedes would consider balances of the lower type in the *Equilibrium of Planes*.

> A quadrilateral, pentagon, cube or other magnitudes of this kind are not more magnitudes than it is the one composed <by the two weights> by means of the <conjunction>. And since it is one unique magnitude, it has *one and only one* centre of gravity.[2]

[1] *Paraphrasis*, p. 42: "Si due magnitudines aequales non idem centrum gravitatis habuerint, magnitudinis ex utrisque magnitudinibus compositae centrum gravitatis erit medium rectae lineae gravitatis centra magnitudunum coniungentis."

[2] *Paraphrasis*, p. 43: "Verum etiam si suspendantur ex C, intelligendum est linea AB in rectitudinem iacere, insuperque sustinere magnitudines AB. Neque magis una est magnitudo quadrilaterum, pentagonum, cubus et huiusmodi aliae, quam sit magnitudo quae componitur ex magnitudinibus A, B una cum linea AB. Quod si est una tantum magnitudo, ergo unum habet centrum gravitatis."

In the following, Guidobaldo deals more closely with the concept *equiponderation*:[1] for balances like in figure I.35 there are certain argumentative difficulties, as the two concepts *equiponderation* and *centre of gravity* do not coincide in this case.
Yet, according to Guidobaldo, Archimedes refers to the isostatic balance in his *Equilibrium of Planes*: he made this reflection in the occasion of Archimedes's first axiom, stating that equal weights equiponderate from equal distances. In effect, the Syracusan's reference to this kind of balance in contrast to the upper alternative in figure I.36 would be testified by the Propositions IV and V of the *Equilibrium of Planes* where he considered the weights as connected between their respective barycentres.
Correspondingly, the first axiom in the *Equilibrium of Planes* would refer also to the case in which the equal magnitudes are arranged on an inclined conjunction (cf. figure I.37) – i.e. on an isostatic balance:

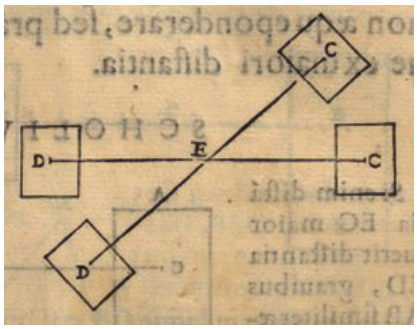

Figure I.37: The statement of "equal weights in equal distances equiponderate" (*Axiom* I, *Equilibrium of Planes*) refers both to horizontal and to inclined balances, according to Guidobaldo.

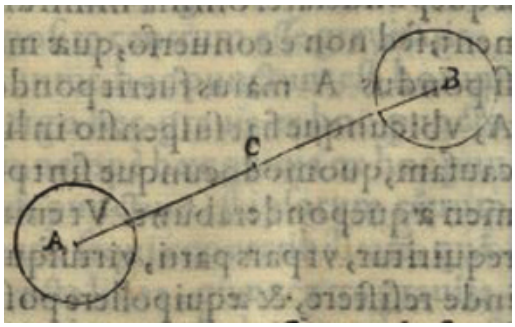

Figure I.38: Another graphical reference to the isostatic balance and the indifferent equilibrium in the *Paraphrasis* (p. 46).

> Moreover, it has to be noted that this postulate of Archimedes is true for weights arranged in any position: both if CED were horizontal, as well as if it were not, as in this first figure <(cf. figure I.37)>; and that it is always true in the same way, that equal weights C, D equiponderate from equal distances EC, ED, as will be clear below (namely after the fourth proposition of this book).[2]

[1] "*Equiponderation*" is the English translation of the Latin "*aequeponderatio*", which on its part derives from the Greek ἰσορροπία. For reasons explained in Part B, II.3.1. its translation with "equilibrium" has to be avoided. Therefore, we use this neologism instead.

[2] *Paraphrasis*, p. 25: "Porro non ignorandum hoc Archimedis postulatum verificari de ponderibus quocunque situ dispositis, sive CED fuerit horizonti aequidistans, sive minus, ut in

Guidobaldo concludes the scholium to the fourth proposition with another *explicit* textual and graphical reference to the indifferent equilibrium (cf. figure I.38): for the isostatic balances (as long as not in the vertical position), *equiponderation* from a certain point means that this point is the barycentre and vice versa:

> It follows from this reasoning that the line AB and the weights will remain in the way, in which they are found <with AB horizontal or not>, as we have proved in our *Mechanicorum Liber*, in the chapter *De Libra* and argued lengthily enough, against those who are of different opinion.[1]

Some pages later, Guidobaldo hints another time at the inclined isostatic balance, in the context of the "preparations" for Proposition VI containing the law of the lever for commensurable magnitudes. As its demonstration bases upon the idea that a magnitude can be substituted by another of the same weight whose *centre of gravity* has the same position, Guidobaldo dwells a while on this point: he regards two equiponderating weights E, A on a balance.

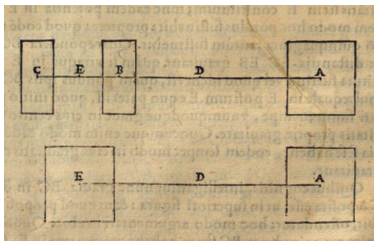

Figure I.39: The substitution of a weight by two others, having together the same gravity and the common centre of gravity at the same place.

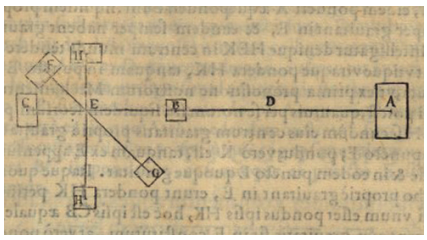

Figure I.40: The array of the substituted weights does not matter as long as the position of the centre of gravity remains the same. So, they can present also an inclination.

If the body in E is substituted by a composed magnitude CB (cf. figure I.39), that weighs equally as much, with barycentre similarly located in the point E, the composed magnitude will similarly equiponderate the weight in A.
In this substitution it does not matter, how CB is applied to the beam, as long as its barycentre coincides with the point E: the composed magnitude can also be inclined, like in figure I.40. This last reasoning obviously constitutes another innuendo to the indifferent equilibrium.

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hac prima figura; eodem modo semper verum esse pondera aequalia C, D ex aequalibus distantiis EC, ED aequeponderare, ut infra (post scilicet quartam huius propositionem) perspicuum erit."

[1] *Paraphrasis*, p. 47: " Ex quibus sequitur lineam AB, ponderaque manere eo modo, quo reperiuntur, ut in nostro *Mechanicorum Libro* in eodem tractatu *De Libra* demonstravimus et adversus illos, qui aliter sentiunt, abunde satis disputavimus."

I.4.4 The *Letter to the Goth*, the dispatch of an isostatic balance to Spain and debates at Pesaro

The difficulty for the scholars of mechanics to accept Guidobaldo's theory of indifferent equilibrium is well illustrated by the topic of the present subsection: in 1598, ten years after Guidobaldo's attempts to convince his sceptics with the edition of the *Paraphrasis* (cf. I.4.3), a former scholar of Christoph Clavius, Botwid von Närke, approached the former criticising Guidobaldo's theory and asking the Jesuit's opinion about it. The German scholar forwarded Botwid's letter directly to the Marchigian mathematician who replied in a polemical tone. Since Botwid must have signed with "Botvitus Nericius de Sala, *natione Gothus*",[1] Guidobaldo calls him quite derogatorily only "Goto" (i.e. Goth). We hence call the document "Letter to the Goth".

Guidobaldo's reply to Botwid's critique

This letter is one of Guidobaldo's most important ones that have survived, from a conceptual point of view, deserving to be exposed here almost entirely.[2]
Botwid's letter to Clavius which had triggered the debate does not seem extant any more. Yet, Guidobaldo's answer permits to reconstruct its content at least partly: its fundamental critique was that the isostatic balance did not rest in the inclined proposition, analogously to what Jordanus, Tartaglia and others had claimed. Botwid must have cited several arguments in his favour: he contested Guidobaldo's direct prove of the existence of indifferent equilibrium and the veracity of *Suppositio* II of the *Mechanicorum Liber*; further, he must have based his critique on the authority of Archimedes, Eutocius and Pappus, probably by citing respective passages in regard; finally, he seems to have adduced experiments, "natural reasons", that apparently confirmed his point of view.
So Guidobaldo wrote on July 28th 1598:[3]

> Most magnificent and honourable Father,
> (...) I have seen what that Goth gentleman writes against you and me, and I have the impression that this man has a tendency to contradict whenever he can, and that he is not lacking in a certain natural conceit. However, I cannot help remarking that he notably wrongs his master and that he is an unworthy disciple, since he apparently does not understand the terms. Anyway, my mind is at rest, because

[1] The letter in question is not conserved. However, in another letter to Clavius, written on February 25th 1597, he signs with "Botvitus Nericius de Sala, *natione Gothus*"; cf. Chr. Clavius, *Corrispondenza*, cit.

[2] The transcription of the entire, original letter is exposed in Appendix I, I.8.4.

[3] Cf. APUG, ms. 530, fols. 188r-189v. Parts of the letter have been published by E. Gamba, V. Montebelli, *Le scienze a Urbino*, cit. Further, it is published in a commented version in Chr. Clavius, *Corrispondenza*, cit.

I have an excellent advocate, for I know that your Reverence will show him his ignorance which makes him also a bit arrogant. As he approaches me, I shall say a few words, although there would not be any need, because your Reverence knows the facts and has a better understanding than myself.
Anyway, I believe that this Goth needs that I elucidate him the <concept> *centre of gravity*, the first proposition of the eighth book of <the *Collectiones Mathematicae* of> Pappus, and the other things he quotes in his favour. By doing so, he reveals to have no good comprehension.
But to come to some particulars, the Goth says I do not understand what *aequeponderare* means; and I instantly confess that I do not conceive that *aequeponderare* means that <the balance> simply is parallel to the horizon, and that *non aequeponderare* implies only that the balance is not equidistant from the horizontal. I have never heard such a definition, and I cannot find anyone who says so, since this would be the destruction of the definition of the *centre of gravity*.

But perhaps the Goth means that I have used this term wrongly: yet this would not be serious, because the terms, in the end, have to be interpreted in the way in which the authorities ("*authores*") have used them. Anyway, I think that if the balance in question (namely the one I consider in the fourth proposition of the *Mechanicorum Liber*) remains at rest when it is not equidistant from the horizontal, it follows that the weights and every object have the same weight; thus, it may and must be concluded that they are of equal weight at that site, because the one is equal in weight to the other, otherwise they would not weigh equally and consequently would not remain at rest. However, this would be a mere quibbling of words: coming to the facts, if my second *Suppositio* of the *Mechanicorum Liber* were false, the Goth would have to prove it, or he would have to find the words in the proof that are wrong. Anyway, I do not prove the fourth proposition of my *Mechanicorum Liber* basing me on the second supposition, as he says, but on the definition of the centre of gravity. So, it is clear how little the Goth understands; even if it is true, that I subsequently confirm this by a proof by contradiction having recourse to this supposition.
But as there is only one truth, it is necessary that the Goth demonstrates where the error lies in the opposite opinion, just as I do with those who have an opinion contrary to mine. In fact, it is not sufficient to say that when the balance is not equidistant to the horizon, the weights are not equal on the basis of the authority of Archimedes, Eutocius and Pappus, because this would mean nothing else than showing that I have not made a correct use of the term *aequeponderare*.

Howbeit, if the weights are not equal in that position, then the proof that I have given is not true; thus, the Goth shall find the error in my proof, as I have said before. But as he shows not to understand the argumentation principle ("*argumentandi modus*") regarding the *centre of gravity* and *aequeponderare*, he can read what I say in my <*Paraphrasis* of *De*> *Aequeponderantibus*; then maybe he will understand if he really wanted to. But as he bases mathematics upon the authorities, I say that Archimedes neither at the beginning nor in the course of both books on the *Equilibrium of Planes*, mentions the equidistance from the horizontal - not even a word about it! Then, still concerning the subject of *centre of gravity*: when weights are sustained in that point, he teaches that they remain at rest in every position, and consequently have the same weight: I have demonstrated this in my comments on that treatise. Anyone who understands Archimedes correctly must interpret him in this way, otherwise none of the conclusions that he draws would be true. And the propositions and declarations are more universal and more satisfactory than if they were demonstrated only when the balance is equidistant from the horizontal. If the proofs of Archimedes were true only when the balance is equidistant from the horizontal, he would have said so, for this would have been a necessary condition to state; but since he has not said this, it is clear that he considers that the balance remains at rest and equiponderates in any position. And further, Archimedes does not mention the balance, but "distances from which", in order to speak more universally.

In his explanation of Archimedes's principles <of the> *De Aequeponderantibus*, Eutocius says that Archimedes means that when a figure or a balance is suspended in its centre of gravity, the figure or the balance is equidistant from the horizontal, and he is right. However, it does not follow that this is not true when they are not equidistant from the horizon, and Eutocius does not say a word about this, because anyone who comprehends what *centre of gravity* and *aequeponderare* signify can understand perfectly well what is meant.

Then, in the first proposition of the eighth book, Pappus does not dedicate a single word to the equidistance from horizon: when he approaches to explain the nature of *centre of gravity*, and of how to locate it in every body, he finds it by means of the segments of the bodies, made with the planes perpendicular to the horizon, and not those which are equidistant to the horizontal. He, as well, does not say a word about this. Indeed, this proof of Pappus is in contrast with the definition that the Goth gives of *aequeponderare* when he says that it means being equidistant from horizon. Pappus teaches that bodies can equiponderate in all positions that the bodies may assume, without there being any equidistance from the horizon.

> And then, I would really like to see the Goth's natural reasons by which he proves my supposition and demonstration to be false: it would be interesting to see how mathematical things can be proved by natural means. Why, then, does the Goth desire to know the names of those that have an opinion contrasting to mine? I believe that I can tell him that everybody follows me (as far as I know); but he will have to be satisfied with the fact that your Reverence is of this opinion which is in contrast to his own. I doubt, however, that he intends to publish this in Spain, for avoiding to bring shame upon himself. I believe that I have said too much about this topic, and leave the matter to what you consider suitable to write. (...)
> I kiss Your hands. May God grant You happiness. From Pesaro, 28th July 1598,
> Your Reverence's servant,
> Guidobaldo dal Monte

So, Guidobaldo's reaction was very harsh and polemical. This was surely owed to the continuous critiques he had met in regard of his theory of indifferent equilibrium. In his defence, he firstly evidenced and justified his conception of *equiponderation*[1] for the isostatic balance: it does not exclusively comprise the case of its horizontal position. This would be a limitation equivalent to the "destruction of the definition of <the concept> *centre of gravity*", and with it, obviously, the whole Archimedean mechanics.[2] Interestingly, Guidobaldo negates in this context to know anybody who defines *equiponderation* by means of the horizontal position of the balance beam – this is a rather curious statement, which regards his reception of what his teacher Commandino had held (cf. I.4.5).

Then, Guidobaldo emphasises that, in his direct existence proof of the indifferent equilibrium, he does not recur to the *Suppositio* II – rightly, in our opinion.[3] Remarkably, Guidobaldo makes in this context an observation about the logical relation of the concepts *equiponderation* and *manere* that seem to contradict to what he had stated in the *Paraphrasis*.[4]

Next, Guidobaldo turns to counter Botwid's citation of the authorities of

[1] "*Equiponderation*" is an English neologism as translation for the Latin "*aequeponderatio*" which on its part derives from the Greek ἰσορροπία. For reasons explained in Part B, II.3.1, its translation with "equilibrium" has to be avoided. Therefore, we use this neologism instead.

[2] Surely, Guidobaldo is right about the fact that this limitation is not reconcilable with Pappus's definition of *centre of gravity*, cf. p. 275. The "Pappian way", however, is not the only one to reconstruct or interpret Archimedes's *barycentre*-theory, cf. Maurolico's approach in Part B, II.3.

[3] Cf. Part A, IV.2.2, in particular footnote 2 on page 138. Guidobaldo recurs to the second supposition only later, when he shows the incompatibility of the *gravitas secundum situm*-theory with Archimedes's.

[4] In the "Letter to the Goth", he claimes: "<*pondera*> *aequaliter non ponderent*, et per consequenza *non manerent*." Analogously, a bit afterwards he states "<*pondera*> *maneant ac per consequens aequeponderent*." For a detailed analysis of this problem, cf. Part B, II.4.

Archimedes, Eutocius and Pappus. The "Goth" could have cited the sixth proposition of Archimedes's *Quadrature of the Parabola* in his favour which seems to contain a hint of equilibrium considered as a stable one by Archimedes (cf. the following subsection I.4.5). In this context, Guidobaldo refers to the scholium after the fourth proposition of the *Paraphrasis* for the conceptual connection of *centre of gravity* and *equiponderation*:[1] he substantially holds that Archimedes has not stated anywhere in the *Equilibrium of Planes* to conceive equilibrium exclusively for the horizontal position of the balance.

His reply in regard of the passage of Eutocius is interesting: in effect, in the comment on the *Equilibrium of Planes*, the latter had stated that the balance has to be thought as parallel to the horizon when it is in equilibrium.[2] Remarkably, Guidobaldo, instead of doubting of Eutocius's authority, tries to counter Botwid's objection with a rather flimsy argumentation: Eutocius would have identified equilibrium with the horizontal position of the beam, but this would not mean that he did not consider also other arrangements as positions of equilibrium.

As far as Pappus and its first proposition of the eighth book of *Collectiones Mathematicae* is concerned, Guidobaldo counters that the former makes statements also for solid bodies in that occasion that generally cannot be situated in a horizontal position (think of irregular solids, *e.g.*).

Finally, "the Goth" must have referred to "experiments" – "natural reasons" – with an alleged isostatic balance that turned to the horizontal position. [3] Guidobaldo turns his opponent into ridicule, by commenting ironically that he would be pleased to hear these "natural reasons" that were allegedly able to contradict a mathematically demonstrated fact. Yet, as the successive paragraph shows, a closely related aspect would have occupied Guidobaldo some months later:

Debates at Pesaro about Botwid's critique and the dispatch of an isostatic balance in Spain

Botwid's critique seems to have provoked a considerable resonance in the scientific environment around Guidobaldo, as the present paragraph will evidence:[4] a first

[1] Cf. Part A, V.2.3 and Part B, II.4.2.

[2] For Eutocius's passage of the comment on the *Equilibrium of Planes*, cf. Part B, II.3.2.

[3] We have already had various occasions to refer to the difficulties to fabricate the isostatic balance as a precision instrument; cf. in regard, for example, the comment Guidobaldo makes add Pigafetta to *Le Mechaniche* and Part A, IV.1.2.

[4] The dispute between Guidobaldo and Botwid was not finished with the former's letter: apparently, Clavius forwarded his letter to Botwid who, on his part, added comments in a polemical tone (conserved in APUG, ms. 530, fols. 188r-189v); on December 20th 1598, he wrote to Clavius in regard (APUG, 530, fols. 134r-136v): "Quod vero attinet ad Illustrem Guidum Ubaldum Montanum, nihil nobis accidere potuit epistol<a> ipsius ridiculosius: tam insolenter enim loquitur, ac si iam controversiam totam penitus sustulerit; cum nondum prima eius fundamenta iecerit. Nam quae scribit, omnia, et ex auctoritate Pappi, male ab ipso per

hint at this fact is a copy of the "Letter to the Goth" that Muzio Oddi has made, apparently because the topic had aroused interest.[1] A confirmation derives from a letter, or more precisely a draft of a letter, that Oddi wrote to a (not named) interlocutor:[2]

> Ho poi fatto vedere al S.r G.<uido> U.<baldo> quello che V.S. mi scrive per conto del rispondere al Goto (...). Et di gratia il S.r G.U. ha inviato a esso Padre una sua scrittura fatta da lui più per compiacerlo che perché giudicasse neccessario il rispondera a persona tanto poco pratica delle Matematiche quanto è il Goto. Io l'ho veduta et mi è parso bella assai et ne scrivere qualche cosa di essa a V.S. acciò ancor Lei ne participasse, ma la memoria mi serve poco da diverso; pur per sodisfare al desiderio Suo, anderò mettendo insieme quelle poche cose che mi riccorderò di essa et di quei discorsi che questo Sig.r ha fatto a bocca con esso ma per facilitarmi l'intelligentia, ma con questo che V.S. mi escusi se seranno [posti senz'ardere] perché prima io non so et poi il sentirmi male, ch'è caggione che non possa supplire con la fatica[3] al mancamento dell'ingegno mio.
> (...) È ben vero che è contrasegno dell'equiponderare quando la libra[4] posta parallela all'orizonte sta fermo[5]; ma non seguita che non essendo parallela all'orizonte non possino aequeponderare che sarebbe un far particollare et un ridurre il millione al diece[6].
> Quando è stato neccessario che la libra aequiponderando stà parallela all'orizonte, Archimede l'ha detto, così nella 6a <propositione> *De Quadratura Paraboles*. Et così dovremo credere che averebbe fatto nei

falsum principium intellecta pendent; et hic iam diu, lippis et tonsoribus, nedum geometris, sunt notissima; utpote plus duodecim annos ultro citroque, variis partium studiis, ad ravium usque agitata. Non videtur, prae nimietate sapientae suae, ut coniicere licet, adduci posse, ut credat homines etiam esse Gothos. (...)" Cf. Chr. Clavius, *Corrispondenza*, cit. Yet, it seems that Guidobaldo did not reply (or not even come to know about) this repeated critique. As the present paragraph will show, however, he sent a real exemplar of the isostatic balance in Spain, in order to convince his critics (including Botwid).

[1] Cf. BUU, Fondo del Comune, Busta 120, Cart. 3, fol. 410r/v. The copied passage begins with the wording "anzi questa dimostratione di Pappo e contraria alla definitione che dà il Goto del *aequeponderare*" and ends with "altramente non saprei mai quello che si voleva dire quest'uomo, dal quale se ne averà altra cosa, mi favorisca di farmene partecipe. Quanto alli problemi etc". Cf. Appendix I, I.8.4.

[2] Cf. BUU, Fondo del Comune, Busta 120, Cartella 3, fols. 418r-419v. For the transcription of the entire letter, cf. Appendix I, I.8.4. Oddi's copy of Guidobaldo's "Letter to the Goth", exposed above, seems to have served to inform this anonymous interlocutor of his.

[3] con ∼ fatica *ex* col studio.

[4] la libra *super lin.* *ex* i corpi

[5] *post* fermo *del.* così cognote anco dal senso

[6] et ∼ diece *ex* quello che è universale

> [prop.ti] trattandovisi *** negl'*Aequeponderanti*[1] // se[2] fosse stata conditione neccessaria, dove non ha mai detto purre una parola di questa aequidistantia, né mai ha nominato orizonte. (...)

So, Oddi summarises the content of the "Letter to the Goth" to his friend, who seems to have been in distant contact with Guidobaldo, too. Interestingly, the latter has apparently shown his reply to Oddi: as the latter, on his part, evidently informed his interlocutors about the debate and as he probably was not the only one to have been let in on this controversy between Guidobaldo and Botwid,[3] the news about the controversy spread in the scientific environment of Pesaro.
But Guidobaldo did not confine himself to inform his scientific interlocutors and friends about the dispute. As the following letter to Pier Matteo Giordani reveals, he was also intended to dispatch an isostatic balance to Spain (!), in order to convince Botwid and his critics at Madrid.
The opportunity was favourable: in 1599, in occasion of the accession to the throne of Philip III (already in 1598), the Duke of Urbino sent ambassadors to the Spanish court to show his reverence, among them also Guidobaldo's interlocutor Count of Carpegna. So, Guidobaldo planned to make him transport a real exemplar of an isostatic balance there.[4]
Yet, because of an anticipation of the embassy's departure, the punctual finalisation of the balance was threatened: so, Guidobaldo wrote to Pier Matteo Giordani (September 21st 1599):[5]

> Ill.re S.r mio hon.do,
> Non averei mai creso che la partita del Conte di Carpegna fusse stata così presta, et io aveva già mandato un filo di ottone a Francesco a Monte Baroccio acciò facci la bilancia. Et ora gli ho scritto che la facci subito et che la mandi in mano di V.S. acciò la mandi subito al Conte di Carpegna con fargli da mia parte un bascia mano.
> Et anche se il detto Conte in Spagna vedesse che questa bilancia ci facesse honore, et che chiarisse con il senso chi non crede questo effetto, la potria lasciar là in mano di qualche persona galante, ma non in mano del Goto, acciò ci fusse là questa bilancia per poter chiarire ognuno. Quel filo di ferro che V.S. ha, non lo mandi che non è apposito. Ma di ogni cosa mi rimetto al Suo giuditio. (...)

[1] *Aequeponderanti* *ex* de aeque
[2] *post* se *del.* l'avesse giudicato
[3] As the letters, exposed in the following, testify, at least also Pier Matteo and Giulio Giordani and Count of Carpegna were informed about the debate.
[4] The fact that Guidobaldo tried to convince critics also in Spain – the remarkable efforts of this enterprise, despite of the favourable opportunity, should be kept in mind – is an ulterior prove of his determination to convince the sceptics in regard of his theory.
[5] Cf. BOP, ms 426, fol. 176r.

Pier Matteo Giordani, on his part, informed his brother Giulio, the Duke's first secretary, about Guidobaldo's efforts to send the balance in Spain.[1]

> Fratello oss.mo,
> Avendomi scritto il Conte di Carpegna che io facessi sapere al Sig.or Guidobaldo che la sua partita doveva esser tra quattro giorni che terminano domani, detto Sig.re per chiarire con l'esperienza i capricci del Goto ha fatto far subito una libra che non si è potuta aver prima di oggi, facendola inviar a me con ordine che se sarè in tempo [vedevi] di ricapitarla. Onde perché il desiderio suo abbia effetto [l'invio] qui [son giunti] in vostra mano acciò, se sarà possibile, capiti in mano del Conte prima che parta. (...)
> Mentre scrivo ho inteso che ci è avviso che il Conte di Carpegna doveva partire questa mattina per Roma. Se sarà vero e fosse possibile farli capitar a Roma questa bilancia, al S. Guidobaldo credo che si faria un gran piacere. (...) Di Pesaro il dì 23 di settembre 1599
> Fratello Amorevolissimo
> Piermatteo

The content of the letter suggests that Giulio, the ducal counsellor, was well informed about Guidobaldo's debate with Botwid: in fact, Pier Matteo confines himself to speaking about "clear the whims of the Goth with the experience", without adding anything else. The end of the letter then shows that Count of Carpegna had already left, probably without the balance.[2]

I.4.5 Guidobaldo's dissociation from Commandino: the sixth proposition of the *Quadrature of the Parabola*

Even if Archimedes's extant writings do not contain any definition of *equilibrium*, there is a passage in the *Quadrature of the Parabola* that seems to shed some light on his conceptions in regard. As the present subsection will present, Commandino and Guidobaldo maintained different standpoints in respect of this matter; the latter's dissociation from his master in this regard was with all probability intentional.

Commandino's edition of the *Quadrature of the Parabola*

In 1558, Commandino had published a Latin translation of the *Quadrature of the Parabola*, together with other Archimedean writings in the *Archimedis Opera*

[1] Cf. BOP, ms 930 (folios without numeration, buy in chronological order).

[2] This does not necessarily mean, however, that in the end Guidobaldo did not succeed in letting arrive the balance in Spain: in effect, Pier Matteo Giordani hinted in the letter to his brother Giulio at the possibility to send the balance to Rome all the same. Further, other letters exposed in Appendix I, I.8.4 document that the embassy passed several weeks in Rome: time enough for Guidobaldo, to forward his balance.

nonnulla.[1] Therein, Archimedes determines the 'area' of the parabola: besides a geometrical argumentation, he has recourse also to a mechanical reasoning, comprising the consideration of a balance. In the sixth proportion, in particular, he applies on one balance arm a triangle $B\Delta\Gamma$ and at the end of the other he attaches a certain weight Z (cf. figure I.41).[2]

> Let us imagine a plane perpendicular to the horizontal; let us call the part in which the point Δ is situated regarding the segment AB the lower part, and the other the upper part. Let the triangle $B\Delta\Gamma$ have a right angle in B and let the side $B\Gamma$ be equal to the half of the balance. Let the triangle be attached at the points B, Γ and a certain area Z from A at the other part of the balance. May this area Z attached at A have such a relation to the triangle $B\Delta\Gamma$, fixed to the balance, that they equiponderate. So I say that the area Z is the third part of the triangle $B\Delta\Gamma$.[3]

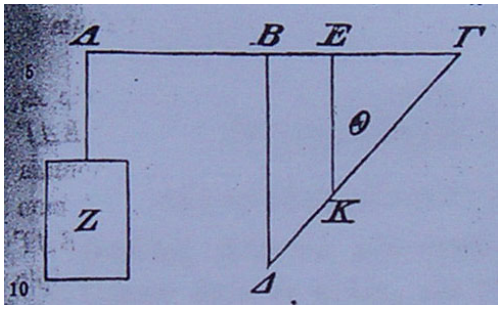

Figure I.41: The sixth proposition of the *Quadrature of the Parabola*.

The demonstration begins with the wording:

[1]The other works contained in the *Archimedis Opera nonnulla* were *The Measurement of the Circle*, *On Spirals*, *On Conoids and Spheroids* and the *Sand Reckoner*. From a mechanical point of view, the *Quadrature of the Parabola* is the most interesting treatise of them.

[2]Archimedes, not only here, regarded plane figures to be endowed with gravity: their area is thought to be directly proportional to their virtual weight. He applies the law of the lever and argumentations regarding the concept *centre of gravity* in order to get information about the area of the figures in question.

[3]Cf. Archimedes, *Opera omnia cum commentariis Eutocii*, critical edition by J.L. Heiberg, Leipzig, Teubner, 1910-15; *Quadrature of the Parabola*, prop. VI: "Fingatur autem planum suppositum ad horizontem perpendiculare, et quae in eadem parte rectae AB sunt, in qua est punctum Γ, infra esse fingantur, quae in aliter, supra, triangulus autem $B\Delta\Gamma$ sit rectangulus angulum ad B positum rectum habens et latus $B\Gamma$ dimidiae librae aequale, suspendatur autem triangulus ex punctis B, Γ et in altera parte librae aliud spatium Z ex puncto A suspendatur, spatiumque Z ex A suspensum cum triangulo $B\Delta\Gamma$ ita se habenti, uti nunc positus est, aequilibritatem servet. Dico igitur spatium Z tertiam partem esse trianguli $B\Delta\Gamma$."

> Since it has been supposed that the balance is in equiponderation, the line $A\Gamma$ is parallel to the horizon (...).[1]

Evidently, this would be a clear clue that Archimedes conceived equilibrium to be stable; or at least, that he did *not* consider the indifferent equilibrium.
Yet, the matter is more complex as it may seem:[2] a glance at the apparatus of the critical edition shows a different situation: the phrase "the line $A\Gamma$ is parallel to the horizon" is an interpretation of Heiberg of a spurious passage.[3]
In effect, in the tradition of the Archimedean text there are essentially two independent versions of the passage, one of them reporting the parallelism of the balance to the horizon (Moerbeke) and the other (Jacobo di San Cassiano, *editio princeps* of Basel) simply speaking of the line $A\Gamma$ (or AC, in Latin translations) "which seems a balance".[4] Thus, on the basis of the current state of the art, it is not possible to decide which version was Archimedes's.
But independently from this last question, this situation had consequences also for Commandino and Guidobaldo: in his translation of the *Quadrature of the Parabola*, the former adopted the following interpretation of the passage:

> Since it is supposed that the balance equiponderates, *the line* AC *will be parallel to horizon.* The line with right angles (...) .[5]

So, Commandino translating interprets the passage as a conception of equilibrium as stable in Archimedes's text. Interestingly, he does not hint in any way at the conceptual importance of this passage:[6] in the comment to the proposition he speaks about a linguistic question and about the position of the barycentre of the triangle (used in the demonstration without prove), yet not a word about this extremely relevant information – as it seems the only place in Archimedes where we (have seemed to) get to know something about his conception of equilibrium.

[1] Heiberg reports the passage in Archimedes, *Opera omnia cum commentariis Eutocii*, cit., with: "Nam quoniam suppositum est libram aequilibritatem servare, recta $A\Gamma$ horizonti parallela erit."

[2] Unfortunately, the translation, or better the paraphrase made by Heath is not appropriate to help us in this question: first of all, it combines the sixth and the seventh proposition in only one theorem and speaks from the beginning about "a lever AOB placed horizontally". He does not minimally hint at the conceptual importance of this proposition.

[3] A detailed analysis of this topic is presented in M. Frank, *Commandino e Guidobaldo: La Proposizione 6 della Quadratura della Parabola e la questione dell'equilibrio*, in "Proceedings International Workshop on Commandino, Urbino 2009", forthcoming.

[4] Detailed information about the various traditions of the Archimedean *corpus* is contained in P.D. Napolitani, *Archimede. Alle radici della scienza moderna*, cit.

[5] F. Commandino, *Archimedis Opera nonnulla*, *Quadratura Paraboles*, fol. 20r: " Quoniam enim positum est libram aequiponderare, *erit AC linea ipsi horizonti aequidistans.* Linea autem ad rectos angulos (...)." The emphasis is ours.

[6] The conceptual importance of a definition of the *equiponderatio* will be dealt with in Part B, chapter II.

Guidobaldo's reaction to Commandino's translation

Commandino might have had his reasons why he favoured this version of the passage in question even if he did not comment his decision. Guidobaldo, however, must have disagreed with his esteemed master, holding that his interpretation of equilibrium as indifferent was *also Archimedes's* conception.[1]
Moreover, as he had explicitly claimed in the "Letter to the Goth", he claimed not know anybody who held this point of view in regard to Archimedes's conception of equilibrium:

> The Goth says I do not understand what *aequeponderare* means; and I instantly confess that I do not conceive that *aequeponderare* means that <the balance> simply is parallel to the horizon, and that *non aequeponderare* implies only that the balance is not equidistant from the horizontal. I have never heard such a definition, and I cannot find anyone who says so, since this would be the destruction of the definition of the *centre of gravity*.[2]

So, Guidobaldo had not read Commandino's translation? Could it be that they have not ever talked about such a crucial point?

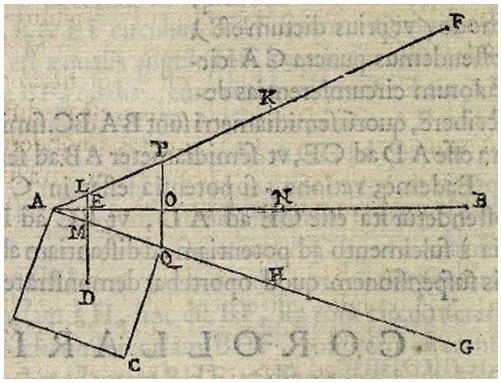

Figure I.42: The fifth proposition of chapter *De Vecte* of the *Mechanicorum Liber*.

There is a passage in the *Mechanicorum Liber* which, with all probability, excludes this possibility: in the fifth theorem of *De Vecte* (cf. figure I.42), Guidobaldo argues that a weight, suspended perpendicularly above its centre of gravity, stands still. He motivates this step stating that:

[1] Let's recall, in this regard, what he had stated in the context of the fourth proposition in the *Mechanicorum Liber* (fol. 5v): "and with my best efforts, I will try to defend not only my own theory, but also Archimedes himself who seem to have been of the same opinion"; further, cf. the "Letter to the Goth": associating *equiponderation* only to the horizontal position of the balance would be a destruction of the concept *centre of gravity*. This, obviously, could not be in accordance with Archimedes.

[2] Cf. Part B, I.4.4.

> At the same way, the weight will remain suspended in E, like suspended from the points A, O themselves, *according to Federico Commandino's comment on Archimedes's sixth proposition of the Quadrature of the Parabola* and according to the first proposition of *De Libra* of this book.[1]

This comment testifies that Guidobaldo knew the sixth proposition of the *Quadrature of the Parabola* of his master Commandino very well.[2] Therefore – quite remarkably – Guidobaldo knew his teacher's interpretation of Archimedes's conception of equilibrium - and negated to know it in front of Clavius and Botwid.

He must have considered his master's translation (and even conception?) as wrong, since he insisted, in various occasions, on the fact that Archimedes could only be understood rightly if his conception of equilibrium was interpreted as indifferent one. Given his high esteem towards Commandino - in the *Mechanicorum Liber* he had described him as "talented in such a way in the mathematical branches that it seems that in him were reborn Architas, Eudoxus, Heron, Euclid, (...) Pappus and even Archimedes himself" - this dissociation is even more remarkable.

Maybe this was the reason why Guidobaldo does not seem to have had the highest opinion of Commandino's mechanical work. Admittedly, the latter was apparently more interested in other mathematical disciplines, but with the restoration of Archimedes's *On Floating Bodies* and the edition of *De centro gravitatis solidorum* (both 1565) he had made accessible a relevant writing on (hydro)statics, until that time nearly incomprehensible, as well as contributed to the restoration of Archimedean mechanics, since any trace of the Syracusan's writings on the barycentres of solids is lost.
Guidobaldo himself held the opinion that the occupation with barycentres was one of the most important parts of mechanics.[3] So, it appears puzzling that he complained in the preface of the *Mechanicorum Liber* that his master had not dealt with mechanics at all, and if ever, so only *en passant* – a sharp contrast to the eulogy of Commandino's occupation with the other mathematical branches.[4]

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[1] *Mechanicorum Liber*, *De Vecte*, prop. V: "Eodem modo pondus in E appensum manebit, ut ab ipsis A, O punctis sustinebatur, *ex commentario Federici Commandini in sextam Archimedis proposi<ti>onem de Quadratura Parabolae* et ex prima huius *De Libra*."

[2] It would seem quite absurd to suppose that Guidobaldo knew only the the comment to the sixth theorem, but not the proposition itself.

[3] Cf. *Paraphrasis*, pp. 20/21: "Itaque peprspicuum est, Archimedem proprie elementa mechanica tradere, quando//quidem duo pertractat, quae sunt tanquam elementa huius scientiae: fundamentum nempe illud praestantissimum iam toties praefatum <i.e. the law of the lever>, deinde centra gravitatis planorum ostendit."

[4] *Mechanicorum Liber*, p. ix (not numbered): "Ille <Commandinus> tamen perpetuo in aliarum mathematicarum explicationum versans, mechanicam facultatem, aute penitus praetermisit, aut modice attigit."

This difference between Commandino's and Guidobaldo's positions sheds a somewhat different light on the usual portrayal of the "School of Urbino" that is usually presented as a group of scholars with a rather monolithic "research programm", and the same interests.[1] In contrast, the present subsection has revealed a notable conceptual conflict, in which Guidobaldo considers Commandino's standpoint as wrong and in disagreement with Archimedes.

I.4.6 Aftershocks of the topic

Even after Guidobaldo's death, the debate about the indifferent equilibrium appears to have gone on: a former disciple of Guidobaldo, the historian Omero Tortora, wrote to Pier Matteo Giordani in 1617:

> Sir Cardinal <Francesco Maria> dal Monte says that the demonstration of Sir Guidobaldo has no weak points, being mathematically most true and, naturally, the case of the increase of the weight cannot occur. (...) Rome, February 17th 1617.[2]

Pier Matteo Giordani, Guidobaldo's closest scientific interlocutor, had evidently approached the latter's brother Cardinal dal Monte,[3] who seems to have been interested and rather talented in mathematics. Even if the mathematical problem submitted by Giordani is not precisely described, there are two hints that the problem in question was the treatment of the isostatic balance:
Firstly, the question was about an "increase of the weight <that> cannot occur", as Guidobaldo had exactly replied against Jordanus, Tartaglia and Cardano according to whom the upper weight fixed on the inclined isostatic balance had gained positional heaviness (cf. figure I.6 on p. 268). Secondly, the bifid argumentation regarding a mathematical and, on the other side, a "natural" level, resembles Guidobaldo's own pleading for the existence of the indifferent equilibrium in *Le Mechanice* (cf. I.4.1).[4]

[1] An interesting study that evidences some aspects of divergence between Commandino and Guidobaldo is D. Bertoloni Meli, *Guidobaldo dal Monte and the Archimedean Revival*, cit.

[2] Cf. BOP, ms 415, fol. 140r/v: "Dice il Signor Cardinale del Monte che la dimostrazione del S.r Guid'ubaldo non può patir niente, essendo matematicamente verissima ancorché naturalmente non possa succedere il caso mai dell'accrescimento del peso. (...) Di Roma il 17 feb.ro 1617".

[3] The passage after the here cited part seems to suggest that a first letter of Pier Matteo Giordani had remained unanswered by the Cardinal. The former must have subsequently contacted his friend Tortora who was living at Rome and in contact with Francesco Maria dal Monte.

[4] Let us recall what Guidobaldo made Pigafetta wrote there: "Laqual cosa <the non-existence of the indifferent equilibrium> in tutto è contraria alla ragione prima, per essere la dimostratione della sudetta quarta propositione tanto chiara, facile, et vera, che non so, come se le possa in modo alcuno contradire. Et poi all'esperienza: concio sia che l'autore abbia fatto sottilissimamente lavorare bilancie giuste a posta per chiarire questa verità, una delle quali ho io veduto

Yet another document hints at the traces that the debates about the indifferent equilibrium had left: Giovanni Colle, from 1600 physician of the Duke of Urbino, published in 1621 an encyclopaedia of those times' knowledge,[1] including at its end also a short overview of mechanics. Interestingly, despite of the fact that neither he nor his "target audience" surely were experts of mechanics, he referred to Guidobaldo's theory of the isostatic balance:

> Ma l'Illustrissimo Signor Guido Ubaldo de' Marchesi del Monte, uomo dottissimo et singolare, ha formato le tre bilancie, fori et centri, et dimostrato con ragioni verissime et argutissime la verità di questa proposta.[2]

The inclusion of this special topic and his hints at Guidobaldo's construction of real models seem to indicate that he had heard about the subject in the scientific environment of Pesaro. It seems plausible, given the fact that he was called by the Duke in 1600, that he had witnessed the aftermath of Guidobaldo's debate with Botwid.

I.5 Hints at theoretical implications and problems

Chapter II of Part B we will deal with a detailed analysis of the implications and problems that Guidobaldo's conception of equilibrium as indifferent entailed for the whole theoretical foundation of his mechanics. The present section confines itself to hinting at these connections:

Guidobaldo's theory of the isostatic balance was strictly connected with his reintroduction of the concept *centre of gravity* in mechanics. Even if Archimedes's (mechanical) writings were accessible to the generality of the scholars at least with the *editio princeps* in 1544,[3] other approaches to mechanics were prevailing in that period: the Aristotelian one that was based on the "principle of the concentric circles"; Jordanus's/Tartaglia's one which regarded the vertical components of the (hypothetical) descents of the weights. And yet other theories exposed by Cardano and Benedetti that did not have recourse to the Archimedean *centre of gravity*-theory.

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in mano dell'Illustre Signor Gio. Vicenzo Pinello, mandatagli dall'istesso autore, la quale per essere sostenuta nel centro della sua gravezza, mossa dovunque si vuole et poi lasciata, sta ferma in ogni sito dove ella vien lasciata."

[1] G. Colle, *De Ragionamenti accademici, poetici, morali, astrologici, naturali et varii dilettevoli et eruditi*, Venezia, Deuchino, 1621. We would like to thank E. Gamba for the indication of this text.

[2] Cf. G. Colle, *De Ragionamenti accademici*, p. 698.

[3] Also L. Gaurico's (1503) and Tartaglia's (1543) editions contained mechanical tests of Archimedes, but not all of them; cf. P.D. Napolitani, *Archimede. Alle radici della scienza moderna*, cit.

Thus, Guidobaldo's treatment of the isostatic balance and the Simple Machines, despite of the considerable success of the *Mechanicorum Liber*, supported a completely different approach, centred on the concept *centre of gravity*.
In the context of defending the indifferent equilibrium, Guidobaldo introduces *inter alia* the consideration of converging lines of action. Yet, this conception constitutes a serious problem for the Archimedean approach: as Part B, II.4.6 evidences, the *centre of gravity*-theory is reconcilable only with the interpretation of the lines of action as parallel ones. Admittedly, Guidobaldo presents a rather convincing "compromise" for the case of the balance – stating that a weight considered autonomously has a line of action converging to the centre of the world; but the conjunction of two weights on a balance effects that their actual lines of force become parallel (cf. I.2.2). Some passages both of the *Mechanicorum Liber* and the *Paraphrasis*, however, seem to indicate that he did not consequently apply this compromise-approach.[1]

However, despite of Guidobaldo's profound comprehension of Archimedes's theory (at least in Pappus's interpretation) – is manifested in this correct treatment of the isostatic balance – he had to pay a remarkable price for the conception of equilibrium as indifferent. In effect, by doing so, he lost a very comfortable, intuitive definition for equilibrium, i.e. that of identifying equilibrium of the balance with the horizontal position of the beam. Guidobaldo explicitly states that this would be the destruction of the concept *centre of gravity* – and he is right, at least as long isostatic balances are considered.
As Part B, II.3.1 evidences, it is easy to end up in a vicious circle in an argumentation that brings into relation the concepts *equilibrium* and a sort of *moment* (or *equiponderation* or *gravitas secundum situm*.[2] A crucial role in order to avoid this situation is assumed by the definitions of the basic concepts: it seems that Guidobaldo was not able to find another valid definition of *equilibrium*. An analysis of this question will be dealt with in chapter II of Part B.

I.6 Conclusions

To sum up what the foregoing sections have exposed, Guidobaldo presented in the *Mechanicorum Liber* a theory of the isostatic balance that was in contrast to the approaches of various authorities like Jordanus, Tartaglia, Cardano, and to some extent also to Aristotle and Benedetti – in fact this subject permits to understand how different the various mechanical traditions were in the sixteenth century and how they entered in dialogue (or in controversy).
Even if the topic of the isostatic balance, nowadays, might seem a secondary mechanical problem, it was one of the most vehemently discussed topics in sixteenth-

[1] Cf. Part A, IV.2.3.
[2] Cf. Part B, chapter II, in particular II.3.1.

century mechanics. A reason for the scepticism towards Guidobaldo's theory, besides the fact that he was contesting authorities like Jordanus, Tartaglia and so on, seems to have been that isostatic balances were high precision instruments that were not at the disposal of the generality of the scholars of mechanics: in contrast, Pesaro/Urbino were centres of the fabrication of (also scientific) precision devices – a fact that appears to be related to his formulation of his treatment of the isostatic balance.

Even if his theory is rather simple from a theoretical standpoint (supposing the use of the Archimedean concepts), he met a considerable opposition against its acceptance, which is documented in his correspondence. To overcome it, he first tried to explain again (mathematically) his solution but with time, he seems to have come to realise that only the material experience could have convinced his critics: he sent isostatic balances to his interlocutors, sparing no efforts as the dispatch of a balance even to Spain testifies.

Yet, for the perseverance of critique – think of Benedetti's theory of the isostatic balance – he decided to use also his successive writings on mechanics to make propaganda for his treatment of the isostatic balance: he made a scholium in regard insert in the Italian translation of the *Mechanicorum Liber* and in his *Paraphrasis* he explained the foundations of Archimedean mechanics, necessary for the comprehension of his own treatment of the isostatic balance. Archimedes would have defended him. The analysis of the *Paraphrasis*, whose edition was partly motivated by the defence of the indifferent equilibrium, emphasises that Guidobaldo's mechanical work was seriously influenced by this topic.

The consequences of his treatment, that seems to have provoked debates also after his death, made him even dissociate from his master Commandino. The latter, in his edition of Archimedes's *Quadrature of the Parabola* (1558), had presented a translation of a decisive passage that (consciously or unconsciously) interpreted the conception of the equilibrium in Archimedes as stable one - in contrast to what Guidobaldo stresses again and again in the *Mechanicorum Liber* and the *Paraphrasis*.

The subject had also profound implications for Guidobaldo's mechanics from a meta-theoretical point of view: it became a kind of "touchstone" of other scholars' theories - who contradicted his solution for the isostatic balance must have used erroneous principles (granted that the rest of the argumentation is correct): when Benedetti presented a contrasting theory of the isostatic balance, Guidobaldo noted on the margin of his exemplar that it follows that Benedetti's whole theoretical foundation must be wrong. A similar method can be identified in regard of the *Scientia de Ponderibus*: starting from the defence of the indifferent equilibrium, Guidobaldo unmasks intrinsic contradictions of the *gravitas secundum situm*-theory in the fourth proposition of the *Mechanicorum Liber*. He concludes opposing the *true* principles of the Archimedean mechanics against Jordanus's erroneous approach.

On the other hand, a serious negative implication of his theory of indifferent

equilibrium was that he hence could not have recourse to the characterisation of equilibrium as state of the balance in the horizontal position. This complicated his attempts to create a coherent Theory of Equilibrium drastically: he does not seems to have been able to compensate this loss.

Eventually, it seems advisable to dwell on the following final consideration: one might object that the topic of the isostatic balance and its indifferent equilibrium has not to be considered as really belonging to mechanics, but rather as an abstract intellectual amusement, as just a theoretical curiosity.
Yet, this obviously cannot be in accordance with the documentation contained in the present chapter, for several reasons: firstly, the vehement discussions in sixteenth-century mechanics show that the isostatic balance was a problem that occupied nearly all "major" scholars of mechanics, even such with a rather practical background as Tartaglia. Secondly, it was closely connected with the problem of the very foundations of the respective theories: sixteenth-century mechanics was composed by various diverging traditions, whose partial incompatibility is brought to light exactly by the problem of the isostatic balance; so, the existence of the indifferent equilibrium was not reconcilable with the *gravitas secundum situm*-theory, with Cardano's *angulus a meta*-magnitude or with Benedetti's approach of the *Diversarum Speculationum Liber*. Thirdly, Guidobaldo's theory of the Simple Machines is based upon the indifferent equilibrium. In the present form, it would not be thinkable without it.

Chapter II

Guidobaldo's "imperfect" Theory of Equilibrium

> Momentum *est vis ponderis a spatio quopiam contra pendentis.*
>
> Maurolico in *De Momentis aequalibus*, def. VIII.

> Centrum gravitatis *uniuscuiusque solidae figurae est punctum illud intra positum, circa quod undique par//tes* aequalium momentorum *consistunt. (...)*
>
> Commandino in *De Centro Gravitatis Solidorum*, fol. 1r/v.

> Momento *è la propensione di andare al basso cagionata, non tanto dalla gravità del mobile, quanto dalla disposizione che abbino tra di loro diversi corpi gravi. Mediante il qual momento si vedrà molte volte un corpo men grave contrapesare un altro di maggior gravità. (...)*
>
> Galileo in *Le Mecaniche*, def. II.

One of the most central problems of early mechanics was the elaboration of a coherent treatment of the magnitude that later was called "static moment": how can two unequal weights equilibrate each other?[1] *From antiquity, several different approaches had been created to address this basic problem - the present chapter deals with the question how Guidobaldo approaches it: in fact, for the importance of the topic in antique and early-modern mechanics, it constitutes one of the most relevant aspects of his mechanics.*
The following sections will document that he does not present a mathematically formalised theory of the concept moment. *Further, it seems that there are some logical incoherences in his treatment. There were elements of his mechanics that constituted serious difficulties for the establishment of a coherent theory. Another plausible reason for its formal incompleteness seems to have been his close orientation towards his antique models.*

[1] A fundamental study on this question and especially on the meaning of the notion *moment* from antiquity to Galileo is contained in P. Galluzzi, *Momento. Studi galileiani*, Roma, Edizioni dell'Ateneo e Bizzarri, 1979. The present chapter intends to take this topic up and analyse Guidobaldo's approach in regard in a more detailed way.

II.1 Introductory remarks

II.1.1 The meaning of "Theory of Equilibrium"

Already in antiquity, scholars of mechanics had recognised that the same weight had different effects on a balance, according to its distance from the fulcrum. So, a certain weight could lift a heavier one if displaced properly, and in particular, unequal weights could equilibrate each other on a balance. But what was the reason for this, basically astonishing, phenomenon? It is does not seem too hazardous to claim that it was particularly the occupation with this problem that led to the conception of mechanics as scientific discipline.[1]
Apparently, the notion *weight* alone did not suffice to describe the state of equilibrium between certain physical bodies. So, explanations had to have recourse to another physical concept, taking into account the variable efficiency of a weight according to its position in relation to the fulcrum, in order to explain equilibrium between two unequal weights, or at least describe its conditions. This concept, according to the respective approach and author, had been called ἰσορροπία, *aequeponderare*, *momentum* or *gravitas secundum situm*.

Figure II.1: Any Theory of Equilibrium approaches the problem of explaining equilibrium between unequal weights. The decisive concept employed will be called "*(proto-)moment*" in the present chapter.

In modern physics, the problem in question has been solved with the introduction of the notion *moment*, and the postulation that two bodies are in equilibrium when their moments are equal, where *moment* is defined as the product of weight and distance. This approach, and partly also its formalisation, essentially has its roots in the works of the Renaissance mathematician Francesco Maurolico and its writing *De Momentis aequalibus*, terminated in 1548, but published only in 1685.[2]
Even if this way of proceeding might seem "natural" nowadays, there have been,

[1] Interesting reflections on this topic are contained in P. Damerow, J. Renn, *et alii*, *Mechanical Knowlede and Pompeian Balances*, Preprint 145, Max-Planck-Institut für Wissenschaftsgeschichte, 2000.

[2] Maurolico proved in this treatise that *moment* can be formalised as geometrical magnitude, given by the composed relation of *weight* and *distance*. Obviously, the mathematics of Maurolico's time, did not have at its disposal neither algebraic notation nor a conception of vectors. Therefore, important aspects of the notion *moments* were still to be integrated in his result.

from Antiquity over the Middle Ages, several other, dissimilar ways to address the problem, considerably differing both in regard of the mathematical development of the respective theories as well as in regard of the physical magnitudes considered in the treatment of the problem: so, as derived magnitude, the concept was brought into relation to other parameters, like the distance of the respective weights from the fulcrum, the velocity or obliquity of the hypothetical descent of the weights, according to the respective theory.
Anyway, in the present chapter we will adopt the following conventions: this concept, expressing the variability of a weight's effectiveness depending on its position on the balance will generally be called *moment* or *proto-moment*, where the second denomination expresses an incomplete state of mathematical or logical formalisation compared to the first one. The overall approaches to the question will be denominated "Theories of Equilibrium".[1]

In order to comprehend Guidobaldo's approach, to understand his particularities and convergences with other theories, it is advisable to have first a look at some of these different Theories of Equilibrium: section II.2 will hint at Aristotle's and Jordanus's respective theories, whereas section II.3 will deal with Archimedes's approach – the most important for the Marchigian mathematician – and its various adaptation and modifications in the course of the centuries of transmission and study. On this basis, in section II.4 Guidobaldo's own Theory of Equilibrium will be analysed.
Yet, before this intent is approached, it appears necessary to dwell a while on a question that is central for the present purpose: when can a physical concept be considered to be (mathematically) formalised? The gentle reader who is used to the analysis of sixteenth-century mathematics might surely skip the following subsection II.1.2.

II.1.2 Reflections regarding the formalisation of physical magnitudes in the context of the Euclidean Theory of Proportions

The topic of the present chapter, Guidobaldo's Theory of Equilibrium is related to a general problem of history of science: when is it justified to assume that a certain scholar had a clear conception of a determinate notion?
In fact, historiography of mathematics, and especially of mechanics, presents various examples that the discovery of certain, "modern" concepts was claimed to be dating already from Antiquity or the Middle ages: so, many manuals on

[1] Another possible denomination might be "Theories of *Moment*": yet, as the fundamental physical concept to be explained is *equilibrium* - while *(proto-)moment* is "only" a device to reach such a description - the nomenclature "Theory of Equilibrium" seems more general and appropriate.

the infinitesimal calculus trace its invention back to Archimedes, or for example, the principle of *virtual velocities* is claimed to be already present in Aristotle's *Quaestiones Mechanicae* or *virtual work* and *moment* in Jordanus's *De Ratione Ponderis*. Such statements, however, seem problematic:
In fact, a modern reader of these ancient scientific writings appears to have the tendency to bring into relation the contents of those texts with the scientific present-day context. But by doing so, the sense of the transmitted text is misinterpreted and distorted; in order to avoid this, it seems appropriate to deal with the meaning of the texts in the context of *their* time, not in *ours*. If these two levels are not sufficiently distinguished, certain words and concepts can assume a meaning they originally had not.

So, when can a scholar be justly said to have had a clear conception of a certain physical notion? One relevant aspect, which might appear banal at first sight, seems to be the designation of the concept in question in a unequivocal way and without terminological oscillations, manifesting the identification of its conceptual autonomy. A further step is its definition, which is essential for the logical coherence of the regarding theory; finally, the statement of the concept's relations and/or dependencies to/on other elementary notions. If these characteristics are satisfied, it seems legitimate to speak of a formalised concept. Particularly for mathematical/physical branches, there seems to be a step that goes beyond this: the creation of a geometrical/algebraic model of the respective concept. In this case we can speak of a mathematically formalised concept.

Turning to the question of the Theories of Equilibrium, the various approaches differ not only in regard of the concepts taken into consideration or the adopted style, but precisely in regard of the extent to which they are formalised (mathematically). As the following sections will sketch out, the theories exposed for example in Aristotle's *Quaestiones Mechanicae* and in Maurolico's *De Momentis aequalibus* could not diverge more: both of them obviously claim that the more a weight is distant from the fulcrum the greater its effect is. But beyond this, they do not have much in common: the former treatise exposes in large parts qualitative argumentations, the latter presents a fully elaborated, quantitative theory with a formalised mathematical structure.
From this perspective, it is necessary to keep in mind what formalisation of physical magnitudes means against the background of the kind of mathematics available to the scholars of mechanics that lived before the seventeenth century with its fundamental mathematical changes. In fact, in sixteenth-century mechanics there were several attempts of various mathematicians, like Maurolico, Galileo, Benedetti, Ghetaldi and others, to formalise basic concepts of this discipline, such as *moment*, *velocity*, *resistance* or *specific weight*: they are all derived magnitudes, i.e. composed by other, elementary magnitudes like *space*, *time*, *weight*, *volume*, etc.

The Euclidean Theory of Proportions

But as they are *derived* magnitudes, *how* could they derive from the elementary physical notions? This might seem a trivial question, but in reality it was not: the mathematics at the disposal of sixteenth-century scholars essentially was the Euclidean Theory of Proportions which was not easily applicable to the exigencies of physical theories: in particular, it did not provide any means to put into relation magnitudes of different physical dimensions (modernly spoken). In fact, the fifth book of Euclid's *Elements* gives the definition of "ratio", core-notion of the Theory of Proportions:

> III. A *ratio* is a sort of relation in respect of size between two magnitudes of the same kind.
> IV. Magnitudes are said to *have a ratio* to one another which are capable, when multiplied, of exceeding one another.[1]

These definitions imply that a ratio could be stated only between magnitudes of the *same* kind: therefore, *e.g.*, the notions *time* and *space* could not simply brought into relation, even if this would have been necessary to formalise the concept *velocity*: an expression like "space divided by time" would not have had any sense in the context of sixteenth-century mechanics, since a magnitude could not be divided by another of a different kind.

Moreover, in general, also the use of algebra was not yet diffused at that time which complicated the situation even more: many statements, that with the use of algebra would have become equivalent, were formally different in the context of the Theory of Proportions.
So, the obstacles to formalise derived physical concepts were considerable. For the sake of illustration, let us have a glance at one of these attempts: in the chapter of the third day of his *Discorsi e Dimostrazioni matematiche intorno a due nuove scienze*, Galileo deals with the formalisation of the concept *velocity*. Even the simplest case of uniform velocities required several pages of propositions and demonstrations until the result that nowadays would simply be expressed with $v = s/t$, could be reached.

Excursus on Galileo's formalisation of *uniform velocity*[2]

Galileo starts the chapter *De motu aequabili* with the definition of *uniform movement*: its parts, covered in (arbitrary) equal spaces of time, are equal.[3] Four

[1] These are the definitions III and IV of the fifth book of the *Elements*, cf. T.L. Heath, *The thirteen books of Euclid's* Elements, cit. For different interpretations of these definitions in Commandino and Clavius, cf. E. Giusti, *Euclides Reformatus*, cit.

[2] Galileo's treatment of this case is exposed here in a detailed way, since it gives an idea of the considerable mathematical and formal effort necessary to formalise even such a simple case as *uniform velocity*.

[3] The definition reads: "Aequalem, seu uniformem, motum intelligo eum, cuius partes quibuscunque temporibus aequalibus a mobili peractae, sunt inter se aequales." Cf. G. Galilei, *Dis-*

axioms follow:

> Axiom I: The space covered in a longer time, regarding the same uniform movement, is bigger than the space covered in a shorter time.
>
> Axiom II: The time in which a bigger space is covered in the same uniform movement, is longer than the time in which a smaller space us covered.
>
> Axiom III: The space run through by a bigger velocity in the same time, is bigger than the one covered by a smaller velocity.
>
> Axiom IV: The velocity with which in the same time a bigger space is covered, is bigger than the velocity in which a smaller space is run through.

On this basis, Galileo comes to the first proposition: if a body is moved uniformly with the same velocity, the covered spaces are proportional to the times in which they were covered.
In fact, let AB and BC be the spaces covered by the body with the same uniform movement, and DE and EF the respective required times (cf. figure II.2). Now, the line BA is produced until the point G, so that GA is a n-multiple of AB; let DI analogously be the magnitude constituting the n-multiple of DE. On the other hand, let CH be the m-multiple of BC and FK the m-multiple of EF.

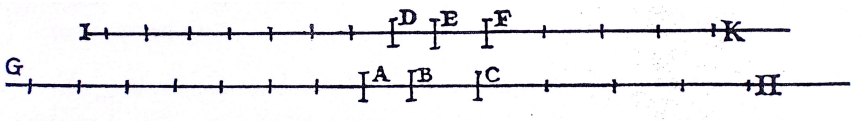

Figure II.2: The illustration of Galileo's first proposition *De motu aequabile*. This figure and the following ones of the present subsection are taken from Galileo, *Opere*, Vol. VIII.

Therefore IE symbolises the time to cover all GB and EK the time to cover BH. Now, as the movement was supposed to be uniform, if the space GB is equal to BH, so also the times IE and EK are equal. If GB instead is bigger than BH, IE is bigger than EK and if GB is smaller than BH, also IE is smaller than EK.
So, (with $GB = n \cdot AB$ etc.) we have the three (in-)equations:

$$n \cdot AB = m \cdot BC \Longrightarrow n \cdot DE = m \cdot EF$$
$$n \cdot AB > m \cdot BC \Longrightarrow n \cdot DE > m \cdot EF$$
$$n \cdot AB < m \cdot BC \Longrightarrow n \cdot DE < m \cdot EF,$$

corsi e dimostrazioni matematiche intorno a due nuove scienze attinenti alla mecanica ed i movimenti locali, edited by E. Giusti, Torino, Einaudi, 1990.

for any natural numbers n, m. This is necessary and sufficient, according to the Theory of Proportions,[1] for stating that

$$AB : BC = DE : EF, \qquad q.e.d.$$

Next, the second proposition states that the spaces are proportional to the velocities if the times are equal. The prove is analogous to the one just exposed: it suffices to interpret DE and EF in figure II.2 as the velocities with which the spaces AB and BC are respectively run through.

The third theorem proves the inverse proportionality of time and velocity, if space is fixed: let A and B be two velocities, A bigger than B, with which the space CD is run through (cf. figure II.3). It has to be proved that the time in which CD is covered by the velocity A is to the time in which it is covered by B, like the relation of B to A.
Imagine a space CE which is to CD as B to A. Proposition II states that the time with which CD is run through by the velocity A – let us introduce the modern symbolism $t_A(CD)$ for this – is equal to the time $t_B(CE)$. On the other hand, according to Proposition I, $t_B(CE) : t_B(CD) = CE : CD$.

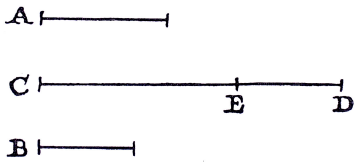

Figure II.3: The illustration of Galileo's third proposition *De motu aequabile*.

The combination of these two relations yields

$$t_A(CD) : t_B(CD) = CE : CD = B : A,$$

where the last equation derives from the choice of CE, *q.e.d.*

So, with these three propositions, Galileo has proved, using again a modern symbolic notation, the three proportionalities

[1]Definition V of Book V of Euclid's *Elements* states: "Magnitudes are said to be in the *same ratio*, the first to the second and the third to the fourth, when, if any equimultiples whatever are taken of the first and third, and any equimultiples whatever of the second and fourth, the former equimultiples alike exceed, are alike equal to, or alike fall short of, the latter equimultiples respectively taken in corresponding order." Cf. T.L. Heath, *The thirteen books of Euclid's* Elements, cit.

Prop I: $(v):\ t \propto s$
Prop II: $(t):\ v \propto s$
Prop III: $(s):\ t \propto 1/v$.[1]

Now Galileo could prove the properties of the composed relations – this is a notion, that comes close to what modernly is expressed with "product": space is the composed relation of velocity and time (Prop. IV), time is the composed relation of space and the inverse of velocity (Prop. V) and velocity the composed relation of space and the inverse of time (Prop. VI).[2] Here, for sake of brevity, only the sixth theorem will be summarised:
Let A and B be two bodies transported by uniform movement. The ratio of the spaces covered by them are supposed to be as V to T, and the times as S to R. So it has to be proved that the relation of the velocity of A to the velocity of B has the composed relation of the spaces V to T and the time R to S.
Be C the velocity with which the body A covers V in the time S - in a symbolic notation $C = v(V;S)$. And be E another velocity which stays at C like the space T to V. Consequently (prop. II), E is the velocity, with which the body B covers the space T in the time S, i.e. $E = v(T;S)$. If G is still another velocity which stays to E like the times S to R, so $G = v(T;R)$ (prop. III).

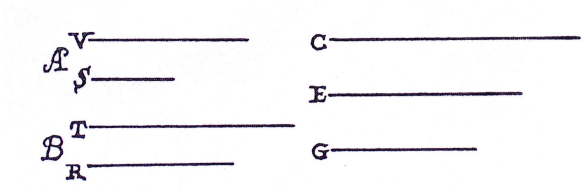

Figure II.4: The illustration of Galileo's sixth proposition *De motu aequabile.*

So, on the one hand

$$C : G = (C : E) \otimes (E : G) = (V : T) \otimes (R : S),$$[3]

and on the other

$$C : G = v(V;S) : v(T;R)$$

So, combining these two equations, the relation of the velocities with which respectively V is covered in the time S, and T in the time R is like the composed relation of the spaces V to T with the times R to S, i.e. of the space with the inverse of the times, *q.e.d.*

[1] Here, the notations $(v), (t), (s)$ mean that, in the respective cases, the magnitudes v, t, s are fixed.

[2] Note, that one of these statements was not sufficient to simply conclude the validity of the other two: in contrast, the modern symbolism $v = s/t$ is equivalent to $s = v \cdot t$ and $t = s/v$.

[3] In this notation, the symbol "$\otimes$" represents the composed relation.

So far Galileo's mathematical formalisation of the model for the uniform movement: it is remarkable how much effort it takes to establish the respective relations even for this simple case. But this is only one example of many other derived physical magnitudes whose formalisation was approached in the course of the sixteenth century. Another one of them will be presented later, namely Maurolico's theory of *moment* (cf. II.3.3).
After the exposition of Galileo's (mathematical) formalisation of a derived physical magnitude, it seems instructive to have a short look, on the other hand, at examples of notions that have *not* to be considered as formalised, according to the aforesaid reflections.

Examples of not (completely) formalised concepts

One example is Benedetti's theory of motion in different media, approached in several writings:[1] the Venetian scholar had recognised that different fluids oppose different resistance to the movement of bodies, according to their material property. So, for example, he postulates in the *Resolutio*:

> Porro suppono proportionem motus corporum similium sed diversae homogeneitatis in eodem medio atque aequali spatio esse quae est inter excessum (in ponderositate inquam vel levitate) supra illud medium, dummodo formam aequalem illis corporibus sortitum fuerit.[2]

This has been unanimously interpreted as the statement of the proportionality between the velocity of fall and the density (or the specific weight), reduced by the Archimedean buoyancy. And in fact, against the end of the treatise, he similarly states:

> Ex his liquet motum magis velocem non causari ab excessu vel gravitatis vel levitatis corporis velocioris collatione tardioris (datis corporibus similis figurae), verum ex differentia speciei alterius corporibus ad alterum, gravitatis levitatisve respectu.[3]

[1] Benedetti deals with this topic in the *Resolutio omnium Euclidis Problematum*, in two different versions of the *Demonstratio Proportionum Motuum localium* and in the *Diversarum Speculationum Liber*.

[2] Cf. G.B. Benedetti, *Resolutio*, p. 7: "Suppongo che la proporzione del moto di corpi simili, ma di diversa omogeneità nello stesso mezzo e per uguale spazio sia la stessa che c'è tra l'eccesso (dico in pesantezza o in leggerezza) rispetto a quel mezzo, purché quei corpi abbiano forma uguale." This work is transcribed in C. Maccagni, *Le speculazioni giovanili* De motu *di Giovanni Battista Benedetti*, cit.

[3] Cf. G.B. Benedetti, *Resolutio*, p. 13: "Da ciò segue che un moto più veloce non è causato dalla gravità o dalla leggerezza del corpo più veloce in relatione al più tardo (dati corpi di figura simile), ma dalla differenza della specie di un corpo a quella dell'altro, relativamente alla gravità o alla leggerezza."

So, it might seem natural to trace back here the introduction of the concept *density* or *specific weight*.
But as a detailed analysis of E. Giusti shows, Benedetti's considerations are not sufficient to speak of a formalised theory of *density* or *specific weight* in the works of the Venetian scholar:[1]

> Che una qualche nozione di densità fosse presente in Benedetti è innegabile; e d'altra parte un'idea di "specie" come grandezza quanto meno suscettibile di confronto era piuttosto diffusa nella dinamica medievale, e in un certo senso era adombrata già nelle definizioni delle *Particella*. (...)
> Ma perché si possa parlare di una grandezza geometrica e si possano considerare i rapporti tra "specie" diverse, non è sufficiente poter istituire un confronto che ci dice quale di due grandezze è maggiore e quale minore, ma occore anche sommare due grandezze o quanto meno occorre definire i multipli di una grandezza data.
> Solo quando siano state definite le modalità con le quali eseguire la somma e il confronto, si potrà usare la quinta definizione del quinto libro degli *Elementi*.[2]

Giusti evidences that the absence of a formulation of the concept of density of specific weight as mathematical magnitude even leads to an incongruence in Benedetti's different writings, regarding the determination of the speeds of fall.

Another example of a mathematical concept not completely formalised is contained in M. Ghetaldi's *Archimedes promotus* (1603), where the Croatian mathematician (1568-1626) deals with the hydrostatic balance. He extensively dwells with the relations between volume (*magnitudo*) and weight (*gravitas*) of different materials, like oil, honey, iron, gold etc. and reports a table that furnishes, for fixed volumes, the weights of bodies made of various materials, whose values are among the best ones known in that period. Correspondingly, the treatise was for a long time interpreted as a determination of specific weights. And in effect, Ghetaldi was well aware of the proportionality between weight and volume for bodies of the same material; he states for example:

> Corpora gravia eiusdem generis magnitudine commensurabilia, eandem in gravitate rationem habent, quam in magnitudine.

However, as P.D. Napolitani has shown,[3] the concept of *specific weight* in the sense of a formalised geometrical magnitude is *absent* in the treatise. On the

[1] Cf. E. Giusti, *Gli scritti* De Motu *di G.B. Benedetti*, in "Bollettino di storia delle scienze matematiche", XVII (1), 1997, pp. 51-104.

[2] Cf. E. Giusti, *Gli scritti* De Motu *di G.B. Benedetti*, cit., pp. 61/62.

[3] Cf. P.D. Napolitani, *La geometrizzazione della realtà fisica: il peso specifico in Ghetaldi e in Galileo*, in "Bollettino di storia delle scienze matematiche", VIII 2 (1988), pp. 139-237.

contrary, he proves that the writing can be interpreted as an attempt to even exclude the *gravitas in specie*, already introduced in medieval treatises on the topic, from the treatment of the hydrostatic balance. In contrast, he bases his mathematical reasonings on the loss of weight in fluids due to the Archimedean law of buoyancy.

II.2 Hints at Aristotle's and Jordanus's approaches to the problem

For a better understanding of the characteristics and crucial properties of Archimedes's, and in consequence also Guidobaldo's Theory of Equilibrium, the present section shortly hints at fundamentally different approaches to the question: the ones exposed in the *Quaestiones Mechanicae* on the one hand, and in Jordanus's *Elementa*.

II.2.1 The treatment of the topic in the *Quaestiones Mechanicae*

The first extant attempt to explain equilibrium between two unequal weights is contained in (Pseudo-?)Aristotle's *Quaestiones Mechanicae*.[1] Therein, the operation mode of many mechanical devices (pulley, winch, oar, etc.) is lead back to the working concepts of the balance, and the latter to the "marvellous properties" of the circle:[2]

> Among questions of a mechanical kind are included those which are connected with the lever. It seems strange that a great weight can be moved with but little force; (...)
> The original cause of all such phenomena is the circle. It is quite natural that this should be so; for there is nothing strange in a lesser marvel being caused by a greater marvel, and it is a very great marvel that contraries should be present together, and the circle is made up of contraries. For to begin with, it is formed by motion and rest, things which are by nature opposed to one another. (...)
> The phenomena observed in the balance can be referred to the circle, and those observed in the lever to the balance (...).[3]

[1] At about the same time as the *Quaestiones Mechanicae*, in China was composed the *Mohist Canon*, which deals as well with balances of unequal arms. The present chapter, however, confines itself to hinting at approaches of the European mechanical tradition. For further information on the Chinese treatise, see J. Renn, M. Schemmel, *Waagen und Wissen in China. Bericht einer Forschungsreise*, Preprint 136, Max-Planck-Institut für Wissenschaftsgeschichte, 2000.

[2] For further information in regard, cf. Part A, III.1.

[3] Cf. Aristotle, *Mechanica*, English translations by E.S. Forster, cit. Also the following translations of the *Quaestiones Mechanicae* in the present chapter are his.

This passage is exemplary for the style used in the treatise: qualitative, partly philosophical argumentations predominate, while mathematical considerations are generally absent. The work is structured in 35 questions on problems with mechanical interest to which the author proposes his answers.
The first question deals with the problem why larger balances are more accurate than smaller. It is here, that the reader comes to know why unequal weights can be in equilibrium:

> Since no two points on one and the same radius travel with the same rapidity, but of two points that which is further from the fixed centre travels more quickly, many marvellous phenomena occur in the motions of circles, which will be demonstrated in the following problems.
> (...)
> Why are larger balances more accurate than smaller? And the fundamental principle of this is, why is it that the radius which extends further from the centre is displaced quicker than the smaller radius, when the near radius is moved by the same force?

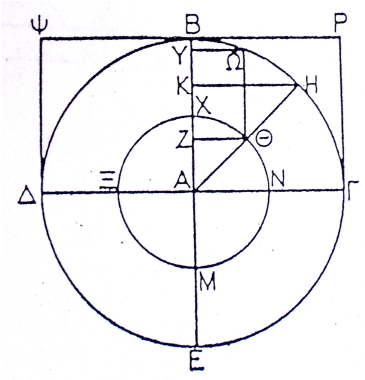

Figure II.5: The comparison of the natural and unnatural components of weight's movement along the circle.

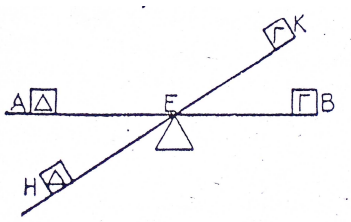

Figure II.6: The figure belonging to Aristotle's third question.

The key idea of the answer of this question is a decomposition of the movements of a moving beam/radius:[1] a "natural" component along the tangent, and an "unnatural", forced one along the radius. And the more a movement is interfered with, *e.g.* by an exterior "force" (so as the beam is constrained to move along a circle around the centre), the slower it gets:

> And, if one of two displacements caused by the same forces is more interfered with and the other less, it is reasonable to suppose that

[1]First, the author proves, that if the proportions between two movements, one downwards and the other sideways, is constant on a certain path, so the path is a straight line. On the contrary, it the proportion varies, so the path would be curved.

> the motion more interfered with will be slower than the motion less interfered with; which seems to happen in the case of the greater and less of the radii of circles. For on account of the extremity of the lesser radius being nearer the stationary centre than that of the greater, being as it were pulled in a contrary direction, towards the middle, the extremity of the lesser moves more slowly. This is the case with every radius, and it moves in a curve, naturally along the tangent, and unnaturally towards the centre. And the lesser radius is always moved more in respect of its unnatural motion;

The author shows, having recourse to one of the few mathematical argumentations of the work, that the "natural component" of the movement, along the tangent, is proportionally bigger than the "forced" one, along the radius, for bigger circles: he considers the two concentric circles $B\Gamma E\Delta$ and $XNM\Xi$ (cf. figure II.5), with their respective radii $A\Theta$ and AH. The natural component of the radius $A\Theta$'s movement is measured by $Z\Theta$, and its unnatural one by XZ. If, in contrast, along the bigger circle the movement with the same natural component $B\Omega$ is regarded, it is easy to prove that the respective component of the unnatural movement BY is smaller than XZ.

The consequence for unequal weights/"forces" is then stated in the third question (cf. II.6), which explains the operation mode of a lever, considering equal weights at unequal distances:

> The further one is from the fulcrum, the more easily will one raise the weight; the reason being that which has already been stated, namely, that a longer radius describes a larger circle. So with the exertion of the same force the motive weight will change its position more than the weight which it moves, because it is further from the fulcrum.

So, all in all, this approach takes into account the movements of the weights along different radii and explains so, that a weight on a longer radius moves more easily. This concept usually is called "principle of the concentric circles".

II.2.2 The *gravitas secundum situm* in Jordanus's *Elementa*

A completely different approach can be found in the mechanical writings of Jordanus.[1] The medieval scholar bases his argumentations upon a concept, called *gravitas secundum situm*, which considers the movements of the weights, similarly to Aristotle. Yet, here ends the similarity: both the used suppositions as well as the adopted style are different: Jordanus's style is axiomatic and his treatise

[1] As exposed in Part A, III.4, there have been transmitted three writings probably composed by Jordanus, namely the *Elementa*, *De Ponderibus* and *De Ratione Ponderis*. For the similarity of their conceptual approach, the present subsection analyses only the *Elementa*.

presents geometric proves of his statements, in difference to Aristotle. We can confine ourselves to dealing in the present subsection with the *Elementa*,[1] since the conceptual structure is the same in all three treatises.

Jordanus adduces seven postulates onto which he bases the nine propositions of the treatise. For our purpose, the most important axioms are:

> IV. It is heavier positionally, when, at a given position, its path of descent is less oblique.
>
> V. A more oblique descent is one in which, for a given distance, there is a smaller component of the vertical.
>
> VI. A weight is less heavy positionally than another, which is caused to ascend by the descent of the other.[2]

Axiom IV introduces the key notion of Jordanus's mechanics, the *gravitas secundum situm*,[3] and the fifth one clears its measurement by the consideration of the vertical component of the (potentially also hypothetical) descent of the weight. The sixth postulate states how to relate this mathematical notion with the physical behaviour of the weights.[4] With these postulates, the author demonstrates theorems concerning the isostatic balance and the angular balance. He correctly enunciates the law of the lever. Strangely, though, he does not seem to use there his *gravitas secundum situm*, but a different, implicit postulate.[5]
So, in order to illustrate his use of the *gravitas secundum situm*, it is advisable to have a look at the second proposition, where he (erroneously) demonstrates the impossibility of indifferent equilibrium for the isostatic balance: the working postulates in the demonstration are the fourth and fifth: if the balance is considered to be horizontal, so the hypothetical descents of the two weights will be equally oblique, therefore, as the weights are equal, neither of them is positionally heavier than the other, and so they remain at rest.
Let us, in contrast, imagine the balance in the inclined position DE and consider

[1] This does not mean that the other writings are less important. On the contrary, the *De Ratione Ponderis*, with its correct statement of the law of the inclined plane and other, many more innovative theorems, is a highly interesting treatise. Yet, the theoretical structure is the same, as it is based, too, on the same axioms exposed in the *Elementa*.

[2] These and the following English translations are those of Moody&Clagett, *The Medieval Science of Weights*, cit.

[3] This nomenclature derives from the Latin wording of the postulate: "Secundum situm gravius esse, quando in eodem situ minus obliquus est descensus."

[4] Note that these postulates refer to weights with *equal* gravity, even if this is not explicitly stated. In fact, they do not furnish any means to compare the (relative) *gravitas secundum situm* of a weight with its *absolute* gravity: this would, on the other hand, be necessary in certain situations, for example in regard of the inclined isostatic balance and the (falsely) claimed impossibility of indifferent equilibrium. See, in this regard, Part B, chapter I, in particular subsection I.2.2.

[5] In regard, cf. B. Ginzburg, *Duhem and Jordanus Nemorarius*, cit.

the hypothetical descents of the weights along arbitrary, equal arcs DA and EV (cf. figure II.7).[1] Now, if the horizontal lines DO, ET and VH towards the vertical axis FG are drawn, the vertical component OC of the descent of the weight along DA is bigger than TH, the vertical component of the descent of the other weight along EV.[2] This means, according to Axiom V, that the descent of the weight along EV is more oblique than the one of the other along DA. So the higher situated weight turns out to be positionally heavier than the lower one, whence, given their equal *absolute* gravity, it presses the beam down on its side until the balance reaches the horizontal position.[3]

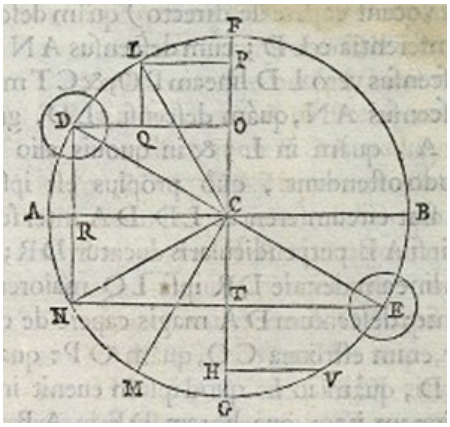

Figure II.7: The second theorem of the *Elementa*: the impossibility of indifferent equilibrium on the isostatic balance.

So, this was an informative example of the working of the *gravitas secundum situm*. Its applicability is different from the Aristotelian "principle of the concentric circles": the former enables statements only concerning *absolutely* equal weights and takes into consideration, as we have seen, different inclinations of the balance beam.

II.2.3 Hints at various Renaissance approaches

The Renaissance substantially did not present completely innovative Theories of Equilibrium. Rather the already existing approaches generally were further elaborated.

[1] It is a characteristic of Jordanus to consider always two *descents* and not the descent of one weight and the ascent of the other. This is connected with the nature of the concept *gravitas secundum situm*: it takes into account only the descent of weights, so for its application it is necessary to consider the virtual case of the descent of *both* weights.

[2] Jordanus justifies this claim recurring to his own work "*Philotegni*", which Moody&Clagett identify with *De triangulis*.

[3] This last consequence is valid, since the arches of descents were chosen *arbitrarily* - so the just exposed reasoning works for every position of the balance between the horizontal and vertical one.

So, Tartaglia essentially exposed Jordanus's theory with the working concept of *gravitas secundum situm*. In the eighth book of his *Quesiti et Inventioni diverse*, he presented an important amplification of the medieval theory, contained in the *De Ratione Ponderis*.[1]
Cardano and Benedetti developed own approaches to explain the equilibrium of the balance, constituting an exception to the tendency of other scholars to revisit ancient and medieval theories in regard. Hints at their approaches are exposed in Part A, III.5.
On the other hand, scholars like Maurolico, Guidobaldo and Galileo were, in a wide sense, followers of the Archimedean approach. As the following section will reveal, both Maurolico and Galileo handled Archimedes's theory rather freely, inserting the notion *moment*. Guidobaldo, in contrast, remained closer to the original theory and tried to reconstruct it without the creation of new mechanical concepts, as section II.4 will document.
Yet, in order to facilitate a better understanding of Guidobaldo's proceeding, the now following section will describe Archimedes's theory and his followers' attempts to reconstruct or develop it further, as consequence of its corruption in the course of its pluri-millennial transmission.

II.3 Archimedes's theory and different attempts of its reconstruction or elaboration

II.3.1 Archimedes's Theory of Equilibrium

Archimedes's mechanical approach to the Theory of Equilibrium – principally[2] exposed in the *Equilibrium of Planes* – considerably differs both from Aristotle's and Jordanus's, as the present subsection will evidence. The Syracusan mathematician considers the basic notions *centre of gravity* and *aequeponderare* and does not have recourse to the consideration of (virtual) movements,[3] in difference to the approaches of the foregoing section. The stile of the treatise is axiomatic and strictly geometrical.[4] It starts with the following seven axioms:

[1]For further information, cf. Part A, III.5.

[2]Other Archimedean writings that have recourse to the same theory are *The Quadrature of the Parabola* and the *Method*. Slightly different conceptions are presented in the *On Floating Bodies* (*e.g.*, think of the convergence of the lines of action).

[3]It has, therefore, been often called a "static" approach, as opposed to the "dynamical" one in the *Quaestiones Mechanicae*. We will not use this classification, as it seems anachronistic: "statics" and "dynamics" are notions that refer to Newtonian physics and thus, using them, one risks to fill ancient or prenewtonian mechanics with contents that there have not been antecedently.

[4]This does not mean that there are not problems on a conceptual level. Regarding those problems, cf. the paragraph below.

1. Equal weights at equal distances equiponderate[1] , and equal weights at unequal distances do not equiponderate but incline towards the weight which is at the greater distance.

2. If, when weights at certain distances equiponderate, something be added to one of the weights, they do not equiponderate but incline towards that weight to which the addition was made.

3. Similarly, if anything be taken away from one of the weights, they do not equiponderate but incline towards the weight from which nothing was taken.

4. When equal and similar plane figures coincide if applied to one another, their centres of gravity similarly coincide.

5. In figures which are unequal but similar the centres of gravity will be similarly situated. By points similarly situated in relation to similar figures I mean points such that, if straight lines be drawn from them to the equal angles, they make equal angles with the corresponding sides.

6. If magnitudes at certain distances be in equilibrium, (other) magnitudes equal to them will also be in equilibrium at the same distances.

7. In any figure whose perimeter is concave in (one and) the same direction the centre of gravity must be within the figure.[2]

In the first three propositions, Archimedes demonstrates the law of the lever in a qualitative version. Then, the fourth and fifth theorem prepare the law of the lever in its quantitative version, stated in the Propositions VI and VII: two weights, whether commensurable or incommensurable, equiponderate from distances indirectly proportional to their gravities.
Archimedes uses this theorem for the determination of the barycentres of certain figures: of the parallelogram (Prop. IX, X), of the triangle (Prop. XIII, XIV), of the trapezium (Prop. XV) and of the parabola (entire Book II): mechanical considerations are used in order to reach geometrical results, and on the contrary, geometrical properties of bodies are used for the determination of their mechanical behaviour.

[1]For reasons explained on the following pages (cf. particularly p. 349), it is advisable not to translate the Greek verb ἰσορροπεῖν with "to be in equilibrium" or even "to have equal moment"; in order to avoid distorting its conceptual meaning, it is rendered here with the neologism "equiponderate".

[2]The translation of these axioms is closely modelled on Heath's, cf. *The works of Archimedes*, ed. by T.L. Heath, Cambridge, University Press, 1897.

Conceptual difficulties of the *Equilibrium of Planes*

Archimedes draws, both in the axioms as well as in the propositions, on the notion *equiponderation*, a neologism with which we render the Greek ἰσορροπία and its Latin translation *aequeponderatio*. But which were the properties of this notion? In fact, there is no definition of this key concept in the writing, nor anywhere else in the extant writings of the Syracusan mathematician. The situation is analogous for the other key concept of the Archimedean tradition, namely *centre of gravity*. Similarly serious is the fact that there are no statements on the reciprocal dependencies of two these magnitudes, and their relations with the concept *equilibrium*.

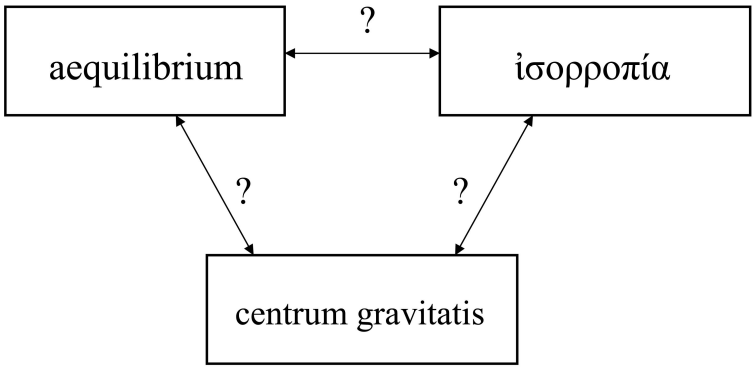

Figure II.8: The basic notions of the Archimedean Theory of Equilibrium: ἰσορροπία (or its Latin translation *aequeponderare*) and *centre of gravity*. In its extant version, it does not present definitions or specifications of their logical relations with the fundamental concept *equilibrium*.

These problems seem to be due to the corrupted version in which Archimedes's treatise has come down to us: as J.L. Berggren points out,[1] the writing presents a series of argumentative incoherences and demonstrative weaknesses that indicate with all probability a corruption of the genuine treatise.[2] Yet, here is not the place to discuss the question what might have been the structure of the original work. Rather, the present section is interested in the characteristics of his extant theory of equilibrium and its reception in the sixteenth century.

[1] Cf. J.L. Berggren, *Spurious Theorems in Archimedes' Equilibrium of Planes Book I*, in "Archive for History of Exact Sciences", XVI (1976), pp. 87-103.

[2] There are, though, also scholars that do not agree this hypothesis, cf. W.R. Knorr, *Archimedes and the pre-Euclidean proportion theory*, in "Archives internationales d'histoire des sciences", XXVIII (1978), pp. 183-244.

The lack of definitions and of the dependencies of the notions *aequeponderare* and *centre of gravity* from the fundamental concept *equilibrium*[1] might seem, at first sight, a theoretical problem of only mathematical-formal interest, since the involved notions seem to relate to each other in an intuitive way. Yet, in reality, the conceptual problem is serious, it is easy to end up in a circular argumentation like this:

> Two weights have the same moment, consequently they will be in equilibrium.

In fact, this is, after all, the function of the notion *moment*: to determine the circumstance of equilibrium. But at the same time, the following statement is equally reasonable:

> Two weights are in equilibrium, so they have equal moments - for if they had not, one weight had a bigger moment and would hence move downwards.

This argumentation is intuitive, yet: it represents a classical vicious circle. This stresses the necessity and importance of defining the basic concepts of any mathematical theory and the unequivocal determination of their reciprocal relations.

Obviously, the conceptual difficulties of the *Equilibrium of Planes* and, more generally, of the Archimedean Theory of Equilibrium had not remained hidden to later scholars. Efforts to restore it occupied many mathematicians over a nearly 2000 years' period: already in late antiquity, Pappus and Eutocius tried to illuminate the survived parts of Archimedes's works. In his comments he deals also with some crucial aspects of the *On the Equilibrium of Planes*. In the Renaissance, after the rediscovery and study of the Archimedean *corpus*,[2] scholars like Maurolico, Guidobaldo and Galileo tried to reconstruct or elaborate the Archimedean theory. These attempts will be presented in the following subsections.

[1] Obviously, *equilibrium* is the fundamental magnitude in Archimedes's treatise, as the other two basic notions *equiponderation* and *centre of gravity* are used to clear the conditions under which two unequal weights equilibrate each other ("law of the lever"). Interestingly, the notion "*aequilibrium*" (i.e. an equivalent Greek analogue) does not compare in the *Equilibrium of Planes*. Another remarkable fact connected with this problem is that in *On Floating Bodies*, Archimedes does not use the notion ἰσορροπία, while he has recourse to the concept *centre of gravity* in his analysis of the equilibrium positions of the paraboloid immersed in a fluid. In-depth studies on this topic would be a *desideratum*, for a better understanding of the notion ἰσορροπεῖν. In the meantime, it seems advisable to render the word with the neologism "equiponderate".

[2] Some of the Archimedean texts were obviously known also in the Middle Ages, cf. M. Clagett, *Archimedes in the Middle Age*, cit.

II.3.2 Important additions by Pappus and Eutocius

Important integrations and explanations of Archimedes's theory stem already from antiquity: namely from Pappus and Eutocius.
Pappus of Alexandria, lived around 300 AD, dedicated the eighth book of his *Collectiones Mathematicae* to mechanics, *inter alia* to the study of the five Simple Machines lever, winch, pulley, wedge and screw.[1] He introduces his treatise with a treatment of the theory of centre of gravities.[2] By doing so, he gives the following definition of centre of gravity:

> We call centre of gravity a certain point of any body within it, from which, if it is imagined to be suspended and held, it remains stable and maintains the position which it had at the beginning, and is not set to rotating in this suspension.[3]

So, Pappus's definition of *centre of gravity* specifies its physical properties, considering the consequences of the suspension of a body from the barycentre - as subsection II.3.3 will show, there is also a mathematical way to define *centre of gravity*.

Eutocius of Ascalon, lived around 500 AD, on his part wrote in his commentaries on the survived works of Archimedes, what - in his opinion - the Syracusan's conception of *equilibrium* has been. He states at the beginning of his comment on the first book of the *Equilibrium of Planes*:

> On the other hand, Archimedes thinks in the present book that the centre of *moment* of a plane figure is the point, from which, if it is imagined to be suspended, the figure remains parallel to horizon. (...) Let there be, for example, the triangle $AB\Gamma$, and in its middle the point Δ from which it is suspended and it remains parallel <cf. figure II.9>. It is clear that the parts B and Γ equilibrate each other and none of them inclines more than the other to horizon. Similarly, let AB be a balance beam <cf. figure II.10>. If the magnitudes A, B are fixed thereon, if the beam is suspended in the point Γ with the parts

[1] Cf. Part A, III.3.

[2] Interestingly, Pappus wanted to reach an rather praxis-orientated audience: he emphasises the utility of the exposed theory for architets and mechanicians: "Horum suo quidque loco una cum aliis theorematis architecto et mechanico utilibus manifestum fiet, si antea omnem de centro gravitatis doctrinam uno tenore exposuerimus." Cf. Pappus, *Pappi Alexandrini collectionis quae supersunt*, critical edition by F. Hultsch, vols. 3, Berlin, Weidmann, 1876-78; vol. III, p. 1029.

[3] Cf. Pappus, *Pappi Alexandrini collectionis quae supersunt*, cit.; vol. III, p. 1031; for the Latin text in Commandino's version, cf. Part B, I.1.2 (p. 275).

A, B in equilibrium, the beam will remain parallel to the horizontal and the point Γ will be the centre of suspension of the magnitudes A, B.[1]

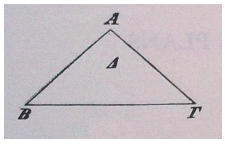

Figure II.9: The figure belonging to Eutocius's first example.

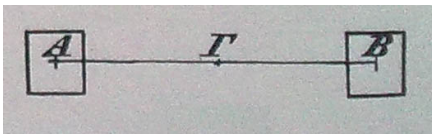

Figure II.10: The figure regarding the second example.

Eutocius introduces here an important idea concerning the connection between *centre of gravity* and *equilibrium*: in his opinion, a body held in its barycentre stays parallel to the horizon, which is equivalent to the conception of *stable* equilibrium. This interpretation is significant as in Archimedes's *Equilibrium of Planes* there was not contained any hint at the Syracusan's conception of equilibrium.[2] Interestingly, though, Eutocius's theory is not compatible with Pappus's definition of *centre of gravity*, as the following sections will show: Also Guidobaldo was confronted with these divergent positions of the two scholars of late Antiquity.

II.3.3 Maurolico: a "new" Archimedean theory

A significant role in the reception and elaboration of Archimedes's work is assumed by Francesco Maurolico (1494-1575). His writing *De Momentis aequalibus* is of particular interest for the purpose of the present chapter, as it attends to a reconstruction of what might have been the Archimedean Theory of Equilibrium.[3] Although the circumstances under which Maurolico created his work[4] are difficult to reconstruct – the works on it expanded over some forty years – it seems that large parts of the conceptual structure have interestingly been created without his cognition of the *Equilibrium of Planes*:[5] on the basis of statements of the

[1] Cf. Archimedes, *Opera omnia cum commentariis Eutocii*, critical edition by J.L. Heiberg, Leipzig, Teubner, 1910-15.

[2] Interestingly, the *Quadrature of the Parabola* contains a clue that seemingly hints at Archimedes's conception of equilibrium. It seems, however, a corrupted passage; cf. Part B, I.4.5.

[3] Maurolico's immense mathematical work is accessible on-line, at the portal of the *Edizione Nazionale*, directed by Prof. P.D. Napolitani, at http://www.dm.unipi.it/pages/maurolic/introfr.htm.

[4] For further information on Maurolico's *De Momentis aequalibus*, cf. E. Giusti, *Maurolico et Archimède: sources et datation du 1er livre du* De momentibus aequalibus, Proceedings of the XXth International Congress of History of Science (Liège, 20-26 July 1997), Brepols, Turnhout, 2001, pp. 33-40. and R. Tucci, *Il* De Momentis aequalibus *di Francesco Maurolico: una proposta di ricostruzione della sua stratificazione testuale*, Master-thesis, University of Pisa, 2004.

[5] Further, it seems that he did not either know the *Collectiones Mathematicae* of Pappus.

Archimedean *Quadrature of the Parabola*,[1] of excerpts of Eutocius's comments, contained in Giorgio Valla's encyclopaedia *De expetendis et fugiendis rebus* and of Vitruvius's *De Architectura*, he reconstructed what, in his opinion, had been Archimedes's original treatise.[2]
These facts explain the remarkable differences between Archimedes's *Equilibrium of Planes* and Maurolico's writing which, although it is clearly based on the Archimedean basic notions, turns out to be more a "creation *ex novo*" than a reconstruction of the Archimedean mechanics.
Maurolico's theory is remarkably developed from the perspective of its mathematical formalisation. With thirteen definitions and eight postulates he meets the problem of the fragmentary logical relations between the Archimedean basic concepts. From a functional standpoint, the following definitions are the most important for our present purpose:

> VII. Centrum gravitatis est punctum, in quod gravi undecumque suspenso, a signo suspensionis acta linea horizonti perpendicularis est.
>
> VIII. Momentum est vis ponderis a spatio quopiam contra pendentis.
>
> X. Aequalia enim momenta sunt gravium aeque ponderantium, sive aeque pendentium.
>
> XI. Gravia vero aeque pondere, seu aeque ponderare dicuntur, cum ab aliquo puncto appensa ita pendent, ut recta quae gravitatum centra, vel appensionum puncta, coniungit horizonti aequi distet.

So, Maurolico gives definitions for the basic notions *centre of gravity* and *moment* (or *aequeponderare*): the *centre of gravity* is characterised *geometrically* (not physically as in Pappus), as the intersection of the perpendiculars from any suspension point. *Moment*, on the other hand, is defined to depend on the heaviness and the position of a weight: two weights would have equal moments, when they are in a horizontal position. Interestingly, Maurolico excludes, by doing so, the possibility of the indifferent equilibrium. A similar restriction was strictly opposed by Guidobaldo, as section II.4 will show.[3]

The Sicilian mathematician develops on these foundations his theory, proving the reciprocal dependencies of the basic notions: Propositions X and XI clarify

[1] Maurolico knew that work in the version of Luca Gaurico's *Tetragonismus* (1503).

[2] Then, between 1544 and about 1550, he came to know the *editio princeps* of the Archimedean *corpus* which contains the *Equilibrium of Planes*. From this point on, he characterises the *De Momentis aequalibus* as his *own* work, not any more a reconstruction of Archimedes, given the notable differences regarding the conceptual structure and the content.

[3] For the crucial significance of the topic indifferent equilibrium in Guidobaldo, cf. Part B, chapter I.

the relation of *aequeponderare* (and so, of *moment*, too) and *centre of gravity*.[1] Propositio XXX then states the law of the lever.[2]
So far Maurolico's reconstruction of the Archimedean theory in a somewhat "traditional" way, exclusively using notions present in Archimedes's extant writings. Certainly, it contains many elements that are missing the *Equilibrium of Planes*, like the distinction between suspension point and point of equilibrium, the explicit relation between *aequeponderare* and the horizontal position of the balance; however, it does not recur to argumentations or concepts that go beyond Greek mathematics.
Afterwards, in contrast, Maurolico develops a second, different approach, by introducing in the argumentations – only now – the concept *moment* and by proving its dependency on the magnitudes weight and distance. The propositions in regard read:

> Propositio XXXVI: Quam multiplex est pondus ponderis ad idem spatium, tam multiplex est momentum momenti.
>
> Propositio XXXVII: Gravia ab aequis spatiis pendentia sunt momentis proportionalia.
>
> Propositio XXXVIII: Gravium aequalium ab inaequalibus spatiis pendentium momenta sunt ad invicem sicut spatia.
>
> Propositio XXXIX: Momentorum ratio componitur ex ratione ponderum, et ex ratione spatiorum a quibus gravia pendent.

So, Propositions 36-38 prepare the main theorem (Prop. 39): the first of the three proves the proportionality between the magnitudes *weight* and *moment*, the second the one between *distance* and *moment* and the third the inverse proportionality between *distance* and *moment*. In the context of the Euclidean Theory of Proportions, these three relations are necessary and sufficient to show that *moment* is the composed relation of *weight* and *distance* (Proposition XXXIX) or, in a modern language, the product of these two magnitudes.[3]

II.3.4 Galileo: two different approaches in *Le Mecaniche*[4]

Another interesting approach to Archimedes's theory is contained in Galileo's *Le Mecaniche*. After a notable preface dealing with the operation mode of mechanical

[1] Prop. X: "Gravia a communi centro suspensa aequeponderant." Prop. XI: "Gravia aeque ponderantia pendent a communi centro suspensa."

[2] Prop. XXX: "Gravia aequeponderantia reciproca sunt spatiis a quibus pendent."

[3] An analogous example of how a composed magnitude had to be formalised in the context of the Euclidean Theory of Proportions is the case of *uniform velocity* in Galileo's *Discorsi et Dimostrazioni*, cf. Part B, II.1.2.

[4] The present subsection refers exclusively to the *long* version of Galileo's treatise; cf. G. Galilei, *Le Mecaniche*, critical edition by R. Gatto, Firenze, Olschki, 2002.

machines,[1] Galileo begins the main part of his *Mechaniche* with the definitions of *gravity*, *moment* and *centre of gravity*. They read:

> Adimandiamo adunque *gravità* quella propensione di muoversi naturalmente al basso, la quale, nei corpi solidi, si ritrova cagionata dalla maggiore o minore copia di materia dalla quale vengono constituiti.
>
> *Momento* è la propensione di andare al basso cagionata, non tanto dalla gravità del mobile, quanto dalla disposizione che abbino tra di loro diversi corpi gravi. Mediante il qual momento si vedrà molte volte un corpo men grave contrapesare un altro di maggior gravità, come nella stadera si vede un picciolo contrapeso alzare un altro peso grandissimo, non per eccesso di gravità, ma sì bene per la lontananza dal punto donde viene sostenuta la stadera; la quale, congiunta con la gravità del minor peso, gli accresce momento ed impeto di andare al basso, col quale può eccedere il momento dell'altro maggior grave. È dunque il momento quel'impeto di andare al basso, composto di gravità, posizione e di altro, dal che possa essere tal propensione cagionata.
>
> *Centro della gravità* si diffinisce essere in ogni corpo grave quel punto, intorno al quale consistono parti di eguali momenti; sì che, imaginandoci tale grave essere dal detto punto sospeso e sostenuto, le parti destre equilibreranno le sinistre, le anteriori le posteriori, e quelle di sopra quelle di sotto. Sì che il detto grave, così sostenuto, non inclinerà da parte alcuna, ma, collocato in qualsivoglia sito e disposizione, purché sospeso dal detto centro, rimarrà saldo. E questo è il punto, il quale anderebbe ad unirsi col centro universale delle cose gravi, cioè con quello della terra, quando in qualche mezzo libero potesse descendervi.[2]

Apparently, also Galileo introduces the notion *moment*. Already in its definition, he exposes a somewhat bi-divided approach: on the one hand, this concept would depend on the weight's distance from the fulcrum ("per la lontananza"), besides naturally on its gravity. On the other hand, however, he characterises it also as the "impetus to go down, composed by gravity, position and by other effects": this reflects Galileo's second approach to *moment*, which takes into consideration the weight's velocity – a novelty in respect of Archimedes's (extant) mechanical writings.
Centre of gravity, in contrast, is defined by an interesting mixture of Pappus's

[1] There, Galileo criticises the opinion that nature can be deceived by the operation of machines which apparently constituted a diffused believe in the sixteenth century. He explains that machines allow to multiply the applied force, yet at the cost of the applied time or the way along which the force works.

[2] Cf. G. Galilei, *Le Mecaniche*, ed. by R. Gatto, cit., pp. 48/49.

and Commandino's definitions. Yet, while the latter had not explained the notion *moment* anywhere in his treatise, despite of using it in his definition,[1] Galileo is able to insert it in a well-defined context.

Next,[2] Galileo demonstrates the law of the lever, using the expression "peseranno egualmente" as translation of the term "*aequeponderare*":

> Pesi diseguali pendenti da distanze diseguali peseranno egualmente ogni volta che dette distanze abbino contraria proporzione di quella che hanno i pesi.

Galileo modifies Archimedes's proof, as he considers the case of a continuous body (cf. the figures II.11 and II.12), and not of discrete weights as in the sixth and seventh proposition of the *Equilibrium of Planes*.[3]

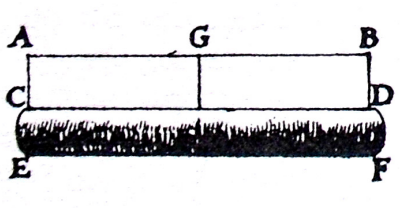

Figure II.11: Galileo considers the cylindrical body CF for his demonstration of the law of the lever.

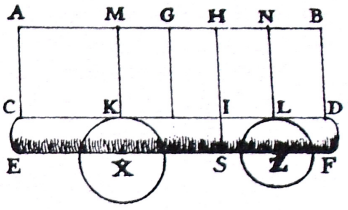

Figure II.12: Galileo shows that the relation of the bodies EI and IF is like the inverse relation of the barycentres' distances to the overall centre of gravity.

After this proof, Galileo revisits the conceptual connection between *moment* and *velocity*: he draws the readers' attention to the relation of the weights' effect with the velocity they would have if they moved together with the balance.[4]

[1] Commandino's definition, exposed in *De Centro Gravitatis Solidorum*, reads: "Centrum gravitatis uniuscuiusque solidae figurae est punctum illud intra positum, circa quod undique partes aequalium momentorum consistunt. Si enim per tale centrum ducatur planum, figuram quomodocumque secans, semper in partes aequeponderantes ipsam dividet." For the Pappian definition, cf. footnote 1 of p. 275.

[2] In reality, between the definitions and the demonstration of the law of the lever, Galileo inserts three postulates, about the motion of weights, about the centre of gravity and the position of the centre of gravity of two equal weights; cf. G. Galilei, *Le Mecaniche*, ed. by R. Gatto, cit., p. 49.

[3] Galileo's proof is more similar to the one exposed in the second book of the *Equilibrium of Planes*: Archimedes shows in the first proposition the law of the lever in a special case, having recourse to the idea of a continuous figure.

[4] This comment is preceded by Galileo's emphasis that there is no difference between moving and sustaining a weight; "an insensible weight" added to one of two weights with equal moments would suffice to make the weights move. But as it is insensible, it would not make

Considering the movement of the weights from B to E and from A to D (cf. figure II.13), the circular arcs AD, BE evidently are proportional to the weights' distances from the fulcrum CA, CB. As the weights move along the arcs in the same time, AD and BE measure the velocities of both movements. So, conclusively, the ratio of the velocities with which the weights cover the respective arcs is the same as the one of the distances of the weights from the fulcrum in the initial position. Galileo concludes that *velocity* could be considered the magnitude that

> compensates the bigger resistance of the weight A while it slowly moves to D and the other quickly moves to E. (...) And by this reasoning we can understand that the velocity of the movement is able to increase the moment of the moving weight, according to the same proportion with which the velocity of the movement is increased.[1]

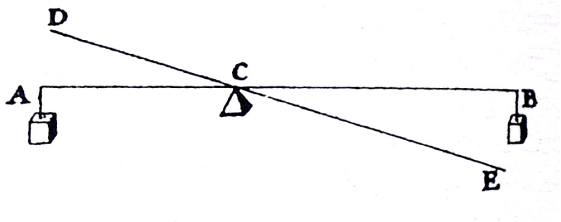

Figure II.13: The proportion of AC to CB is the same as between the circular arcs AD to BE which measure the weights' motion (in equal times).

So, Galileo states the proportionality between the notions *moment* and *velocity*. Although he had started his treatment of the balance with an argumentation that had recourse to the Archimedean notions *centre of gravity* and *aequeponderare*, he presents this second approach that differs *in substance* from the one contained in the *Equilibrium of Planes*. He applies this "dynamical" approach whenever it turns to be more useful than the "traditional" Archimedean one in his treatment of the mechanical machines in the main part of *Le Mecaniche*.

---

sense to distinguish between a weight that moves or only sustains another weight. By holding this opinion, he assumes a position contrasting Guidobaldo's in the *Mechanicorum Liber* who explicitly states that the *potentia sustinens* is smaller than the *potentia movens*; cf. Part A, IV.2.4.

[1]Cf. G. Galilei, *Le Mecaniche*, ed. by R. Gatto, cit., p. 53: "La velocità del moto del grave B compensi la maggior resistenza del peso A, mentre egli in D pigramente si muove e l'altro in E velocemente descende. (...) E da questo discorso possiamo venire in cognizione, come la velocità del moto sia potente ad accrescere momento nel mobile, secondo quella medesima proporzione con la quale essa velocità di moto viene augumentata."

II.4 Guidobaldo's Theory of Equilibrium

The precedent sections were necessary to expose both the theoretical context in which Guidobaldo's occupations with the Theory of Equilibrium were embedded, as well as different approaches that are useful to understand the particularities of his conception. As this section will evidence, Guidobaldo strictly orientates towards the extant elements of Archimedes's mechanics: in fact, of all "Archimedean" approaches presented in the last section, Guidobaldo is the one who follows the theory exposed in the *Equilibrium of Planes* with the highest fidelity to the transmitted text.[1]
Guidobaldo addresses the subject not in one, single treatise: the elements of his Theory of Equilibrium have to be extracted from several writings and documents, namely from the *Mechanicorum Liber*, the *Paraphrasis* and the "Letter to the Goth". In order to have an overview of them, the present section first presents the respective passages – like an inventory of his conceptions –, before the first conclusions regarding his approach are drawn in the last subsection II.4.5.

II.4.1 The *Mechanicorum Liber*

Conceptual clarifications of the concepts *centre of gravity* and *aequeponderare*

An obvious weakness of the transmitted form of Archimedes's theory is that the definition of the Archimedean basic concept *centre of gravity* and specifications of its properties are absent. Guidobaldo, however, due to the fact that he was Commandino's disciple, had access to Pappus's *Collectiones Mathematicae* even before their publication in 1588. He consequently knew the definition of this notion that Pappus gave therein and included it in his *Mechanicorum Liber*.[2]
Immediately after the Pappian definition, he adduced also Commandino's that recurs to the notion *moment*. Interestingly, Guidobaldo does not waste a single word about the properties of this undefined notion or its logical connection with the other concepts, like his master Commandino.
He formalised important aspects of this concept in the three *Suppositiones* of the *Mechanicorum Liber*:

> I. Unius corporis unum tantum est centrum gravitatis.
>
> II. Unius corporis centrum gravitatis semper in eodem est situ respectu sui corporis.

[1] As far as his opinion about the approaches presented in II.2 is concerned, he held Aristotle in high esteem: in the *Paraphrasis*, he expresses that the Stagirite had explained mechanics' foundations very well. Jordanus's theory, in contrast, is harshly criticised by him, concluding that the very principles onto which it is based would be wrong.

[2] The wording of Pappus' definition is reported in II.3.2.

III. Secundum gravitatis centrum pondera deorsum feruntur.

So, while Pappus's definition had cleared the physical properties of the notion *centre of gravity*, Guidobaldo tried with these axioms to specify its mathematical dimension: the first postulates the barycentre's existence and uniqueness in any body. The second one, modernly spoken, guarantees its positional invariability in a body under translations and rotation.[1] And the last postulate connects it with its physical properties, relating it with the body's motion.

Another interesting fact is the fact and the way that/how Guidobaldo presents his *Communes Notiones*, presented immediately before the *Suppositiones*, which deal with the concept *aequeponderare*:

> I. Si ab aequeponderantibus aequeponderantia auferantur, reliqua aequeponderabunt.
>
> II. Si aequeponderantibus aequeponderantia adiiciantur, tota simul aequeponderabunt.
>
> III. Quae eidem aequeponderant, inter se aeque sunt gravita.

Evidently, Guidobaldo applies a part of the axiomatic structure of the Euclidean *Elements* to his treatment of mechanics: in fact, the first three "Common Notions" of *Elements*-Book I read:

> I. Things which are equal to the same thing are also equal to one another.
>
> II. If equals be added to equals, the wholes are equal.
>
> III. If equals be subtracted from equals, the remainders are equal.

Guidobaldo's orientation, regarding the concept *aequeponderare*, towards the *Elements* that constituted *the* axiomatic treatment of geometry seems to be rather significant: it testifies the attempt to found a sound conceptual basis of this notion.

Proposition VI of *De Libra*

In the sixth proposition of the chapter *De Libra*, Guidobaldo proves a statement for the balance that turns out to be relevant for our purpose. It reads:

[1] The sense of this postulates gets clear from its use in Proposition IV *De Libra* about the indifferent equilibrium; cf. Part A, IV.2.2.

> Prop. VI: Equal weights, suspended at a balance, have the same proportion in gravity as in space.[1]

In this wording, "in gravity" obviously has not the meaning of "in absolute gravity", as the weights are supposed to be equal.[2] In contrast, here Guidobaldo intended "gravitas" as *effective, variable heaviness* of the weights in question, hence referring to the concept *proto-moment*. Therefore, the proposition and its demonstration reveal important information on Guidobaldo's Theory of Equilibrium. So, it is advisable to analyse it more closely.[3]

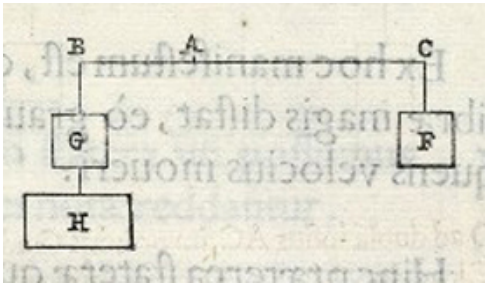

Figure II.14: One of the figures of the Proposition VI of *De Libra*.

Initially, two equal weights G, H are fixed in B and C, arbitrarily distant from the fulcrum.[4] Now, let us imagine that in B, instead of the initial weight G, there is a weight H with $H : F = AC : BA$. Then, according to the law of the lever, H in B equiponderates F in C; as the weights G and F are equal, they can be

[1] *Mechanicorum Liber*, fol. 34r: "Proposition VI: Pondera aequalia in libra appesa eam in gravitate proportionem habent, quam distantiae, ex quibus appenduntur." Interestingly, the *Meditatiunculae*, traditionally supposed to be written between ca. 1587 and 1593, contains the same statement with the same demonstration. This somewhat puzzling fact is dealt with in Part A, chapter VI.

[2] Further, also the demonstration states "as <the weight> H stays at <the weight> G, so the gravity of H stays at the gravity of G, since they are fixed int he same point". Now, this statement would be completely superfluous, if "gravitas" meant *(absolute) gravity*.

[3] Guidobaldo gives two demonstrations of which the second one is particularly interesting. We confine ourselves to reporting that one.

[4] As Guidobaldo's wording has to be interpreted very carefully, the demonstration is cited here entirely, in order to avoid misinterpretations. *Mechanicorum Liber*, fol. 35r: "Sit libra BAC, cuius centrum A in punctis vero BC pondera appendantur aequalia G, F; sitque primum centrum A utcunque inter B, C. Dico pondus F ad pondus G eam in gravitate proportionem habere, quam habet distantia CA ad distantiam AB.
Fiat ut BA ad AC, ita pondus F ad aliud H, quod appendatur in B: pondera HF ex A aequeponderabunt. Sed cum pondera F, G sint aequalia, habebit pondus H ad pondus G eandem proportionem, quam habet ad F. Ut igitur CA ad AB, ita est H ad G. Ut autem H ad G, ita est gravitas ipsius H ad gravitatem ipsius G, cum in eodem puncto B sint appensa. Quare ut CA ad AB, ita gravitas ponderis H ad gravitatem ponderis G. Cum autem gravitas ponderis F in C appensi sit aequalis gravitati ponderis H in B, erit gravitas ponderis F ad gravitatem ponderis G, ut CA ad AB, videlicet ut distantia ad distantiam, quod demonstrare oportebat."

substituted in the relation above; and therefore $H : G = AC : BA$.
Now – calling $m_Y(X)$ the effective heaviness of a weight X in the point Y – since H and G are fixed in the same point

$$H : G = m_B(H) : m_B(G),^1$$

and consequently $m_B(H) : m_B(G) = AC : BA$. Since H in B equiponderates F in C, they have the same effective gravity, i.e. $m_B(H) = m_C(F)$.[2] So, conclusively,

$$AC : BA = m_B(H) : m_B(G) = m_C(F) : m_B(G).$$

This means that the effective gravities of F in C and G in B have the same ratio as AC and BA, which represent the respective distances of the weights to the fulcrum, *q.e.d.*[3]

Several aspects of the proposition and its demonstration are noteworthy: firstly, Guidobaldo does not use an autonomous denomination for the *proto-moment*: while *pondus* remains a concept to express an invariable, material property of a weight, *gravitas* becomes an ambiguous notion: it oscillates between the "gravity" as the (absolute and invariable) heaviness of a weight and the mutable effectiveness of a weight according to its position in relation to the fulcrum.[4]

Secondly, the Marchigian mathematician connects the concept *equiponderation* with this *effective heaviness* or *proto-moment*: two weights have the same effective gravity (in regard of a certain point, the fulcrum), when they equiponderate: this is symbolised by the equalisation of $m_B(H)$ and $m_C(F)$ in the aforesaid demonstration. He had formalised this statement as third point of the *Communes notiones*: "Quae eidem aequeponderant, inter se aeque sunt gravia."

Thirdly, Guidobaldo uses the fact that, for equal distances, the weights are proportional to their effective heavinesses. However, Guidobaldo does not prove this statement.

---

[1] *Mechanicorum Liber*, fol. 35r: "Ut autem H ad G, ita est gravitas ipsius H ad gravitatem ipsius G, cum in eodem puncto B sind appensa."

[2] *Mechanicorum Liber*, fol. 35r: "Pondera H, F ex A aequeponderabunt. (...) Cum autem gravitas ponderis F in C appensi sit aequalis gravitati ponderis H in B, ..."

[3] In the second part of the prove, Guidobaldo shows the same result for the case that the two weights in question lie on the same side in regard of the fulcrum.

[4] Also P. Galuzzi, in *Momento*, cit., comes to this conclusion, cf. p. 62: "Guidobaldo - come il Commandino e tanti altri - incontrò, dunque, qualche difficoltà nell'isolare un termine o un'espressione capace di esprimere senza ambiguità il concetto di «momento del peso»- che dipende, oltre che dal peso, da altre circostanze, in modo da distinguerlo opportunamente da quello generico di «inclinazione». Così entrambi (...), si limiteranno a seguire l'assai infelice metodo tradizionale consistante nel distinguere il *pondus* (constante) dalla sua efficacia variabile nella bilancia (generalmente indicata con *gravitas*)." As the present and successive subsections evidence, however, Guidobaldo's approach is characterised by more facets as the one of his ambiguous use of *gravitas*: in effect, the Marchigian mathematician reached a partial formalisation of the concept *proto-moment*.

Also a problem addressed immediately after the sixth proposition is highly interesting for our purpose: dealing with the "*statera*", the so-called Roman balance, Guidobaldo states: "we can use the Roman balance also in another way to get to know the gravities of weights". Given two unequal weights G and D (cf. figure II.15), how can one come to know how much they weigh, using only the counterweight of the Roman balance?
The demonstration is simple: the weights get attached in the points from where they respectively equiponderate the counterweight E in A. So we have the two relations $G : E = AC : CF$ and $D : E = AC : CB$. Therefore, $D : G = CF : CB$, and so the problem is solved.

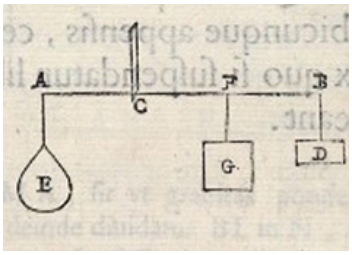

Figure II.15: Guidobaldo's reasoning regarding the "*statera*".

In the demonstration, Guidobaldo uses the fact that if both of the weights G, D equiponderate to the counterweight E, they have the same *effective heaviness*. So, with this argument, the result of the demonstration is that, given equal effective heavinesses of two bodies, their weights are in inverse proportionality to their distances from the fulcrum.

So, summarising the contents of the sixth proposition and the reflections on the *statera*, he has obtained the following results (using the same symbolic notation as in subsection II.1.2, p. 338):

$$(w): \quad m(X) \propto d(X)$$
$$(m): \quad d(X) \propto 1/w(X).$$

In this context, he uses also the following proportionality (without prove, though):

$$(d): \quad m(X) \propto w(X)$$

Regarding the mathematical requirements for the formalisation of composed magnitudes in the context of the Theory of Proportions,[1] all three relations necessary for the characterisation of the notion *moment* (or *aequeponderare*) as composed relation by the magnitudes *distance* and *weight*, are present in Guidobaldo's *Mechanicorum Liber*. Certainly, one of them remains unproven, its demonstration is analogous to that of the other two relations.

[1] Cf. II.1.2 with the example of Galileo's *De motu aequabilis*.

The digression of Proposition IV

Proposition VI is not the only place of the *Mechanicorum Liber* dealing with the problem of the varying effectiveness of a weight on a balance. Interestingly, Guidobaldo exposes also another, completely different approach to this question, in the lengthy digression after Proposition IV of *De Libra*.[1]

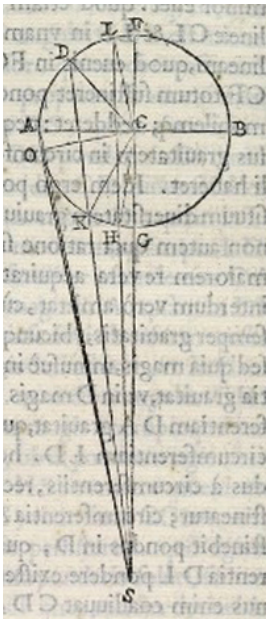

Figure II.16: In Proposition VI *De Libra*, Guidobaldo *inter alia* determines the inclination of a rotatable beam for which the attached weight is positionally heaviest.

The context is distinct from the one of Proposition VI, due to the fact that Guidobaldo deals with a different problem: it is in function of different inclinations of a single, rotatable balance beam – not in function of the distance from the fulcrum – that he considers the varying effectiveness of a weight attached to it (cf. figure II.16).[2]

[1]For further information in regard, cf. Part A, IV.2.2. Obviously, Propositio IV *De Libra* has to be interpreted with caution: it seems that the consideration of converging lines of action initially constitutes an *argumentum ad hominem*, since Tartaglia had claimed their convergence without using it then in the demonstration. So, Guidobaldo wanted to show Tartaglia's error, coming to a different result by drawing on converging, and not on parallel lines of action. Yet, as an analysis of this proposition shows (cf. Part A, IV.2.2), Guidobaldo seems to have been sympathetic to the idea of converging lines of action, beyond the fact that it came in useful to him for showing that Tartaglia's reasoning was incoherent and wrong. From this perspective, the converging lines would *not* have remained an *argumentum ad hominem*, but become an effective part of Guidobaldo mechanical theory. We deal with this problem in a more detailed way in II.4.6.

[2]The triggering moment of Guidobaldo's occupation with this question was Jordanus's and

In this occasion, Guidobaldo states that the effective heaviness of a weight varies, according to the inclination of the rotatable beam to which it is supposed to be fixed, for substantially two reasons: firstly, the weight rests to different extents upon the beam and on the unmovable centre C. Secondly, the *real* way of descent of the weight differs to varying degrees from the path of its (hypothetical) *natural* descent.

In the demonstration of these facts, Guidobaldo draws on the conception of *converging* lines of action: the vertical axis of the circle described by the rotatable balance arm is prolonged to the centre of the world S (cf. figure II.16). Let OS be the tangent to the circle from S to the contact point O,[1] and D and L arbitrary points on the circumference, connected with S.
Guidobaldo's first argumentation concerns the extent to which the weight rests upon the beam (in the case when it is located underneath the beam, the extent to which the weight is held by it). If the beam is in the vertical position, clearly the whole weight is sustained by the beam (or by the centre C); consequently, the effective heaviness of the weight is zero in this position: in fact, the decisive magnitude is the angle between the (converging) line of action of the weight and the beam. If the weight is in the position O, the angle is right[2] and thus, the weight neither rests upon the beam, nor it is held by it: it hence reaches its highest effective heaviness in O.

As far as the second argument is concerned, the effective heaviness depends as well on the measure by which the actual descent of the weight along the circumference differs from the line towards the centre of the world, i.e. from the path along which it would descend according to its nature as heavy body (in the Aristotelian sense): the mixed angle SLD is bigger than SDA, therefore the descent of the weight in D, along the circumference DA, is nearer to its *motus naturalis* than the descent of the weight in L, along LD, to its line of natural descent LS. Consequently, the weight in D is less impeded than the one in L, thus it moves in a more natural way and is, consequently, heavier in L.[3] If the weight is finally situated in O, so its descent along the circumference cannot be nearer to its natural line of descent, being OS the tangent from S to the circumference.

This idea of distinguishing two kinds of (*natural* and *unnatural*) motion and the conception that a weight is heavier the less its descent is distant from is path of *natural* descent, is similar to the conception exposed in the prologue of the

Cardano's claim that the weight was effectively most heavy in the horizontal position. This is true for *parallel* lines of action. Yet, as Guidobaldo supposes *converging* lines, he contests their statement, cf. Part A, IV.2.2.

[1] Guidobaldo proves that O has to be situated below A.

[2] OS is supposed to be the tangent to the circle.

[3] *Mechanicorum Liber*, fol. 11r: "Pondusque magis liberum erit in D quam in L: cum pondus naturaliter magis per DA moveatur quam per LD, quare gravius erit in D quam in L."

first question of the *Quaestiones Mechanicae*.[1] This consideration of Guidobaldo might therefore be called a somewhat "Aristotelian" approach to the problem of the varying *effective heaviness* of weights.

II.4.2 The "*argumentandi modi*" in the *Paraphrasis*

One of the reasons that contributed to Guidobaldo's publication of the *Paraphrasis* was the intent to defend his theory of the indifferent equilibrium.[2] From the publication of the *Mechanicorum Liber* eleven years before, he had persistently received critiques in regard. One of the problems in this context apparently was the insufficient explication of the logical relations between the basic notions of the Archimedean theory,[3] to which he, on his part, had drawn on in order to show his theory of the isostatic balance.
For this purpose, the Marchigian mathematician included several paragraphs in the treatise dealing with central questions of the Theory of Equilibrium. It is in the preface and in certain scholia between the Archimedean propositions, where Guidobaldo inserts these paragraphs, calling them "*argumentandi modi*" i.e. something like "argumentation-principles".

The preface[4]

In the preface, Guidobaldo again inserts Pappus's definition of *centre of gravity*, as he had already done in the *Mechanicorum Liber*. Similarly, he reports also here Commandino's definition rightly after Pappus's.
Afterwards, he emphasises the sense of this definition – i.e. concerning the barycentre as point, from which, if a body is imagined to be held in it, it stands still – drawing on central assumptions of the Aristotelian natural philosophy and conception of the cosmos. His argumentation seems like a justification for having adopted the Pappian definition - comprehensively, since it assumes a crucial role

[1] Cf. II.2.1: "And, if one of two displacements caused by the same forces is more interfered with and the other less, it is reasonable to suppose that the motion more interfered with will be slower than the motion less interfered with (...)." Surely, the passage of the *Quaestiones Mechanicae* considers the *velocities*, and not the weights. The text, however, clearly attributes to a weight with higher velocity a higher effect than to one with less. This can be interpreted in the term of a different *effective heaviness*.

[2] Cf. Part A, V.2 and Part B, I.

[3] In fact, in a letter Guidobaldo advises a critic of his theory of the indifferent equilibrium to read his *Paraphrasis*: "But as he <i.e. the critic> shows not to understand the *modus argumentandi* from centre of gravity to equiponderation, he might read what I say in my comments <i.e. the *Paraphrasis*> on the 4th proposition of Archimedes's book *De Aequeponderantibus*, which perhaps will make thins clearer for him (...)." The letter in question is the so-called "Letter to the Goth" which has already been exposed in Part B, chapter I. It will be dealt with again in the following subsection II.4.3, as it contains important information on Guidobaldo's Theory of Equilibrium.

[4] For a more detailed description of Guidobaldo's argumentation, cf. Part A, V.2.

in Guidobaldo's motivation of his theory of the indifferent equilibrium for which he had received continued critiques.
Further, he concludes the preface of the *Paraphrasis* with the appeal that the cognition of Archimedes's demonstrations show the scholar of mechanics, how he has to argue and demonstrate in mechanics - Guidobaldo speaks here precisely about the *argumentandi modi*, i.e. the elements of the Archimedean (and his) Theory of Equilibrium.[1]

The scholium to Proposition IV

The fourth proposition of Archimedes's work states: if two equal magnitudes do not have the same centre of gravity, so the centre of gravity of the magnitude composed by them is situated in the midpoint of the line that links the centres of gravity of the two initial magnitudes. Its demonstration contains two properties of the concept *centre of gravity* that cannot be found elsewhere in the Archimedean *corpus*: firstly, the common centre of gravity of two connected magnitudes lies on the line through their centres of gravities. Secondly, there is a statement on the relation between the two key notions *centre of gravity* and *equiponderation*: a body held in its centre of gravity equiponderates.
As these elements offer the possibility to reconstruct elements of Archimedes's Theory of Equilibrium, Guidobaldo dwells for not less than seven (!) pages on the implications for the Theory of Equilibrium.[2]

After some reflections on the question when a body has to be considered a composed magnitude, hence possessing one, and only one unique centre of gravity,[3] Guidobaldo turns to the first element of Archimedes's Theory of Equilibrium, i.e. the first "*argumentandi modus*":[4] he specifies the relation between *centre of gravity* and *equiponderation*. According to what Archimedes states in the demonstration, a body/magnitude, held in its centre of gravity, equiponderates. So far this logical implication; but what about the other? Can be concluded, from the fact that weights equiponderate regarding a certain point, that this point necessarily is the barycentre of the system? Guidobaldo argues that this inverse logical relation is *not* universally true: it is valid for (not vertical) isostatic balances, i.e.

[1] *Paraphrasis*, p. 21: "Et quod admirabilius est, nos non solum pro fundamento suscipere posse ad aliquod demonstrandum theoremata in his libris demonsrata, verum etiam ab his demonstrationibus perdiscere ipsum modum argumentandi et demonstrandi, ut suis locis ostendemus." With "*ut suis locis*", Guidobaldo alludes to the scholia after the fourth and before the sixth propositions.

[2] It is this scholium he advised his critic Botwid von Närke to read; cf. II.4.3.

[3] Also this is a central question of Archimedes's mechanics: it is decisive, with its consequences for the concept *centre of gravity* in the demonstration of the law of the lever. However, it is not strictly related to the problem we are dealing with now, so we do not dwell on it here.

[4] Cf. *Paraphrasis*, p. 44: "Argumentandi modus inest in hac demonstratione maxima consideratione dignus, et huius scientiae maxime proprius."

the type of balances treated by Archimedes, in his opinion. Yet, it is not valid in general, as the angular balance or the isostatic balance in the vertical position prove (cf. figures II.17 and II.18).
In fact, let us consider the angular balance of figure II.17: equal weights are fixed in A, B. Obviously, the midpoint C of AB is the barycentre of the mechanical system. Now, if the system is held in D, vertically above C, it doubtlessly stays at rest. But, according to Guidobaldo's theory, it does not only stand still, but it even equiponderates.[1]

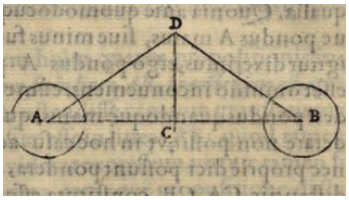

Figure II.17: An angular balance ADB, held in D.

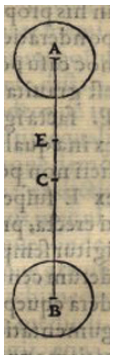

Figure II.18: The isostatic balance in the vertical position.

Now let us imagine an isostatic balance in the vertical position, as in figure II.18: in this case, Guidobaldo distinguishes between the notions *manere* – which expresses something like "to be at rest", "to be in equilibrium" – and *aequeponderare*:

> Obviously, everything that equiponderates, is at rest, but not the contrary: i.e. what is at rest, <does not necessarily> equiponderate.[2]

This is a general statement, valid for all balances. Interestingly, in this second case, the weights *stay at rest*, but do not *equiponderate*, if held in the point E, according to Guidobaldo's theory.[3]
Yet, regarding the conceptual complications that arise from angular balances or isostatic balances in vertical positions, Guidobaldo declares that they can be

[1] Cf. *Paraphrasis*, p. 45: "Suspendatur autem pondera A, B ex D et aequeponderent; non sequitur tamen, ergo D centrum est gravitatis magnitudinis ex A, B compositae. Centrum enim gravitatis in linea existit AB, quae centra gravitatis magnitudinum A, B coniungit, nempe in C."

[2] Cf. *Paraphrasis*, p. 45: "Omnia nimirum, quae aequeponderant, manent, sed non e converso, quae manent, aequeponderant."

[3] Cf. *Paraphrasis*, p. 45: "Et quamvis magnitudo ex ipsis A, B composita ex E suspensa maneat, non propterea sequitur ergo E centrum est gravitatis magnitudinis ex ipsis A, B compositae - nisi forte accidat suspensio ex puncto C. Praeterea vero advertendum est in hoc casu pondera A, B, dici quidem posse, manere, non autem aequeponderare."

excluded from the investigation, given their remote pertinence to the topic.[1] In the following, Guidobaldo tries to describe *equiponderation* independently:

> Necessary for the equiponderation of weights is that one part has to resist and to be equally powerful (*aequipollere*[2]) as the other, and that the force of one is able to resist and to be equally powerful (*aequipollere*) as the force of the other: so they can be justly said to equiponderate. This can happen only, when the parts have determinate gravities from determinate distances.[3]

This could be interpreted as something like an attempt to define this crucial concept - at least, it shows that Guidobaldo was aware of the fact that the properties of the concept were still somewhat nebulous.[4] At the same time, Guidobaldo evidently did not attribute the same importance to this description or, in the best case, definition, as he attributed to the definition of the concept *centre of gravity*: the latter was exposed at the very beginning of the *Mechanicorum Liber*, together with the axioms, also in the *Paraphrasis*, its fundamental role was emphasised, not only linguistically with the characterisation of "definition". The former, in contrast, was contained in the middle of a digression of various pages, without an emphasis of his conceptual importance.

"A work for beginners"

Guidobaldo called the *Paraphrasis* "a work for beginners", in a letter to the young Galileo.[5] Considering the remarkable efforts Guidobaldo had to spend to mend a considerable number of conceptual and technical problems in the text, this statement might seem surprising at first sight.

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[1] Cf. *Paraphrasis*, p. 46: "Idcirco quando linea AB est horizonti erecta, proprie ad rem nostram minime pertinet. Ex dictis igitur semper valet consequentia: hoc punctum horum ponderum centrum est gravitatis, ergo si ex hoc suspendantur, pondera aequeponderant. Non autem e converso, nisi quando argumentatio sumitur sempre ex recta linea, quae centra gravitatis magnitudinum coniungit, et quando haec linea non est horizonti erecta."

[2] "*Aequipollere*" is a after-classical Latin word, composed by "*aequus*" and "*pollere*", where *pollere* means "to be strong, be powerful, flourish, thrive, be able, prevail, avail" (cf. *A Latin Dictionary* of Lewis&Short). *Aequipollere*, or *aeque pollere* was often used in contexts of logics, cf. the *Totius Latinitatis Lexicon* of E. Forcellini, *et alii*.

[3] Cf. *Paraphrasis*, pp. 45/56: "Ut enim pondera aequeponderent, requiritur, ut pars parti, virtusque unius vituti alterius hinc inde resistere et aequipollere possit, ut proprie dici possint pondera aequeponderare. Et ut hoc evenire possit, oportet, ut partes ex determinatis distantiis determinatas quoque habeant gravitates."

[4] To my knowledge, this concept had not been defined in any printed writing, at that time. Also Maurolico's *De Momentis aequalibus*, where a definition of *aequeponderare* is adduced, remained unpublished until the late seventeenth century.

[5] Cf. BNCF, ms Gal. 88, fol. 13r: "volevo mandarGli il libro <*Paraphrasis*> il quale è apunto finito di stampare adesso. Io conosco benissimo che V.S. non ha punto bisogno di questo comento, ma il libro è fatto per i principianti."

From the perspective of what we have exposed above, however, it is comprehensive: in the work, he deals with the very foundations of Archimedes's mechanics, with its literally elementary notions. Not only the statements of the propositions (law of the lever, the positions of the barycentres of the triangle and trapezium) would be useful and necessary to know for any scholar of mechanics: but also, and particularly, the way itself to structure argumentations and to demonstrate could (and would have to) be learned from the Archimedean proves, according to Guidobaldo:[1] that is, the elements of the Theory of Equilibrium, with the reciprocal relations of the basic notions *manere*, *aequeponderare* and *centre of gravity*.

In effect, how difficult it was to distinguish these concepts and to keep present their reciprocal relations, can be concluded from a letter that Francesco Guerrini, a disciple of Guidobaldo, wrote after the latter's death to Clavius: as it reveals, the former and a circle of scholars around him, had difficulties with the problem if a figure, intersected by a line through its centre of gravity, was divided in two equal parts (and therefore, if the area was identified with a virtual weight, in equally heavy parts):

> After the death of the Most Illustrious Guido dal Monte, may God rest his soul, several gentlemen of the city of Pesaro have asked me to show them the practice of Guidobaldo's *Le Mechaniche*, as I do. We have already finished the first book *Della Libra*, and at the beginning there has been a great controversy about the definition of the centre of gravity, about these words: "If a plane is drawn through this centre, intersecting the figure in an arbitrary way, so it will divide it always in equiponderating parts."
> And if one wanted to insist in the wording "intersecting in an arbitrary way", it would seem that the two parts, after the section, would weigh equally, but in reality the contrary can be proven. (...)
> I beg you to let me know Your opinion which will be the greatest favour to me.[2]

So, the implied problem is the distinction between the concepts *gravity* and *proto-moment*: the fact that a figure is divided in two equiponderating parts (or: endowed with the same moment) does not generally mean that they have the same

[1] Cf. *Paraphrasis*, pp. 20/21: "Itaque perspicuum est, Archimedem proprie elementa mechanica tradere. (...) Et quod admirabilius est, nos non solum pro fundamento suscipere posse ad aliquod demonstrandum theoremata in his libris demonstrata, verum etiam ab his demonstrationibus perdiscerere ipsum modum argumentandi et demonstrandi, ut suis locis ostendemus."

[2] The letter is published in E. Gamba, V. Montebelli, *Le Scienze a Urbino nel tardo Rinascimento*, cit.; and in Chr. Clavius, *Corrispondenza*, critical edition by U. Baldini and P.D. Napolitani, cit. It has already been reported in Part A, II.3, as it is an important testimony of a circle of scholars interested in mechanics at Pesaro around the year 1600.

area/gravity, even if this might seem intuitive, at first sight. The reason is that also the distances between the centre of gravity of the single parts to the centre of gravity of the whole system have to be considered.
The controversy of the circle of scholars at Pesaro shows us the difficulties of comprehension of the single basic concepts and their reciprocal logical relations.[1] Guidobaldo must have been aware of them, when he inserted in the *Paraphrasis* a lemma in which he attends to exactly this question: he proves that the two parts of a figure divided by a line passing through its centre of gravity are not necessary equal.[2]

II.4.3 The "Letter to the Goth"

In 1598, the Swedish mathematician Botwid of Närke approached his former teacher Clavius with a critique of Guidobaldo's theory of indifferent equilibrium concerning the isostatic balance. The German mathematician forwarded this letter to Guidobaldo, whose answer regards key elements of his Theory of Equilibrium:[3]

> (...) But to come to some particulars, the Goth says I do not understand what *aequeponderare* means; and I instantly confess that I do not conceive that *aequeponderare* means that <the balance> simply is parallel to the horizon, and that *non aequeponderare* implies only that the balance is not equidistant from the horizontal. I have never heard such a definition, and I cannot find anyone who says so, since this would be the destruction of the definition of the *centre of gravity*.
>
> But perhaps the Goth means that I have used this term wrongly: yet this would not be serious, because the terms, in the end, have to be interpreted in the way in which the authorities ("*authores*") have used them. Anyway, I think that if the balance in question (namely the one I consider in the fourth proposition of the *Mechanicorum Liber*) remains at rest when it is not equidistant from the horizontal, it follows that the weights and every object have the same weight; thus, it may and must be concluded that they are of equal weight at

[1] Meaningfully, Guerrini and the scholars did not try to solve the problem by theoretical argumentations: he describes a figure, divided by a line/plane through its barycentre, whose two parts have been weighed, "proving" that they do not possess equal gravity.

[2] Guerrini apparently did not know this passage against the end of the first book of the *Paraphrasis*.

[3] Cf. APUG, ms. 530, fols. 188r-189r; the letter is published in E. Gamba, V. Montebelli, *Le Scienze a Urbino nel tardo Rinascimento*, cit.; and in Chr. Clavius, *Corrispondenza*, critical edition by U. Baldini and P.D. Napolitani, cit. An English translation has already been exposed in Part B, I.4.4: in effect, this letter is of fundamental importance both for the topic of the indifferent equilibrium (treated in Part B, chapter I) as well as for Guidobaldo's Theory of Equilibrium.

that site, because the one is equal in weight to the other, otherwise they would not weigh equally and consequently would not remain at rest. (...)
But as he shows not to understand the argumentation principle ("*argumentandi modus*") regarding the *centre of gravity* and *aequeponderare*, he can read what I say in my <*Paraphrasis* of *De*> *Aequeponderantibus*; then maybe he will understand if he really wanted to. But as he bases mathematics upon the authorities, I say that Archimedes neither at the beginning nor in the course of both books on the *Equilibrium of Planes*, mentions the equidistance from the horizontal - not even a word about it! Then, still concerning the subject of *centre of gravity*: when weights are sustained in that point, he teaches that they remain at rest in every position, and consequently have the same weight: I have demonstrated this in my comments on that treatise. Anyone who understands Archimedes correctly must interpret him in this way, otherwise none of the conclusions that he draws would be true. And the propositions and declarations are more universal and more satisfactory than if they were demonstrated only when the balance is equidistant from the horizontal. If the proofs of Archimedes were true only when the balance is equidistant from the horizontal, he would have said so, for this would have been a necessary condition to state; but since he has not said this, it is clear that he considers that the balance remains at rest and equiponderates in any position. And further, Archimedes does not mention the balance, but "distances from which", in order to speak more universally. (...)
Then, in the first proposition of the eighth book <of the *Collectiones Mathematicae*>, Pappus does not dedicate a single word to the equidistance from horizon: when he approaches to explain the nature of *centre of gravity*, and of how to locate it in every body, he finds it by means of the segments of the bodies, made with the planes perpendicular to the horizon, and not those which are equidistant to the horizontal. He, as well, does not say a word about this. Indeed, this proof of Pappus is in contrast with the definition that the Goth gives of *aequeponderare* when he says that it means being equidistant from horizon. Pappus teaches that bodies can equiponderate in all positions that the bodies may assume, without there being any equidistance from the horizon. (...)

So, summarising the main statements of this letter, Guidobaldo firstly does not agree with a definition of the concept *aequeponderare* based on a conception of *stable* equilibrium (parallelism of the balance beam to horizon). It would not simply be improper, it would even be equivalent to the "destruction of *centre of gravity*": what is the reason of this radical statement?

Well, it seems closely connected with his discovery of indifferent equilibrium,[1]: he had realised that on a certain type of balance weights could be at rest, and even equiponderate, also in inclined positions of the balance beam, if held in their common barycentre. So, limiting the concept of *equiponderation* to the horizontal state of equilibrium only, the Pappian definition of *centre of gravity* would not be true any more: it postulates the manifestation of equilibrium whenever a body is held in the barycentre. This had to be valid in particular for isostatic balances in inclined positions. Pappus's definition was the main argument on which Guidobaldo had based his treatment of the isostatic balance. As chapter I of Part B has evidenced, the Marchigian mathematician considered this discovery as one of the most important elements of his mechanics. Therefore, he could not accept a statement that contested a crucial argument of its mathematical prove.

Besides the defence of his own theory, Guidobaldo hints at another reason that has induced him not to accept the horizontal position of the balance as exclusive position of equilibrium: also in other mathematical disciplines can be observed that Guidobaldo was concerned about establishing his theories as universal as possible. He intended therefore, to create a theory not only valid for a certain kind of balance (of stable equilibrium): as his disciple Muzio Oddi would have said, this limitation would have been a "reduction of a million to ten".[2] In particular, Guidobaldo refers to irregular bodies, considered by Pappus in his first proposition of the eight book of the *Collectiones Mathematicae*, as examples that a theory drawing on the parallelism of the balance beam to horizon cannot be universal.[3]

Finally, Guidobaldo's reaction is most interesting in the light of what we have exposed in II.3.3: Maurolico characterises the notion *aequeponderare* exactly in the way that the former considers a destruction of *centre of gravity*: in effect, the Sicilian mathematician had adopted a different definition of the barycentre.[4]

Secondly, in the "Letter to the Goth", Guidobaldo seems to contradict his own statements exposed in the *Paraphrasis*: in the letter, he argues that the notion *manere* logically implies the concept *aequeponderare*:

> la libra (...) *manet* quand'ella non è equidistante all'orizonte, ne seguita che li pesi et ogni cosa *aequaliter ponderent*, donde si può dire, e

[1] Cf. Part B, chapter I.

[2] Cf. BUU, Fondo del Comune, Busta 120, Cartella 3, fols. 418r-419v; see Appendix I, I.8.4.

[3] Cf. the following statement of Guidobaldo in the "Letter to the Goth": "E così le propositioni e le dimostrationi sono più universali e più belle che se le dimostrassero solo quando la libra è all'orizonte equidistante." And afterwards: "Pappo vuole che li corpi possino *aequeponderare* per tutt'i versi, massime che li corpi si posson dare che non ci possi esser mai l'equidistanza all'orizonte. (...)".

[4] Maurolico's definition reads: "Centrum gravitatis est punctum, in quod gravi undecumque suspenso, a signo suspensionis acta linea horizonti perpendicularis est."

> si deve dire, che in quel sito *aequeponderant, quia alterum aequeponderant alteri*, altramente aequaliter non ponderent, et per consequenza non manerent.

In contrast, in the *Paraphrasis* he had stated that the concept *aequeponderare* implied the one of *manere*, while the inverse logical implication would **not** be valid in general:

> Besides, it should be pointed out that in this case the weights A, B can be said to be at rest, but they do not equiponderate. In fact, all bodies that equiponderate are at rest, but not on the contrary, i.e. what is at rest does not necessarily equiponderate.[1]

So, these argumentations might seem similar to the vicious circle exposed in II.3.1 (p. 349).
Now, one can object in Guidobaldo's favour that the cited statement of the letter refers to the isostatic balance, for which the notions *manere* and *aequeponderare* are equivalent (as long as it is not in the vertical position). Yet, also in a successive passage of the letter, he seems to reconfirm *generally*, what he had stated in regard of the isostatic balance:

> <Archimede>, come anche in tutti due quei libri, non nomina mai l'equidistantia all'orizonte, che di questo *ne verbum quidem*, che trattando sempre del centro della gravità quando li pesi sono sostenuti in quello, vuole che in ogni sito *maneant ac per consequens aequeponderent*.

II.4.4 Considerations concerning Guidobaldo's terminology

The precedent three subsections have presented the passages in which Guidobaldo attends to questions connected with the Theory of Equilibrium. Before, on this basis, a résumé is approached in II.4.5, it seems advisable to take into account another important aspect: the terminology that Guidobaldo uses in order to express the conception of *effective heaviness* and the related notions.
As this subsection will testify, he does not present, to a large extent, a distinct and uniform terminology, neither for the conception of a weight's *effective heaviness*, nor for the notion *equilibrium*.
This is an important aspect, hinting at the possibility that the Marchigian mathematician's interests did not primarily concern the formalisation of the *protomoment*. By doing so, he clearly distinguishes himself from Maurolico and, to some extent, also from Galileo who both realised the importance of its conceptual novelty.

[1] Cf. *Paraphrasis*, p. 45: "Praeterea vero advertendum est in hoc casu pondera A, B, dici quidem posse manere, non autem aequeponderare. Omnia nimirum, quae aequeponderant, manent, sed non e converso, quae manent, aequeponderant."

The denominations *gravitas*, *aequeponderare* and *momentum*

Various different denominations can be tracked down with which Guidobaldo expresses the variability of a weight's effect in function of other physical magnitudes (like the distance to the fulcrum, or the inclination of a balance beam): in the *Mechanicorum Liber*, he prevailingly denominates it with the word "*gravitas*", in the *Paraphrasis* and in the "Letter to the Goth" mainly with *aequeponderare*, while the *Paraphrasis* reports also some recurrences of the word *momentum*.

The absence of an autonomous term expressing the varying effect of a weight leads to a conceptional ambiguousness of the notion "*gravitas*": it sometimes refers to an invariable property of the body in question (i.e. its weight), and sometimes, in contrast, its *effective heaviness*, depending on its distance from the fulcrum, and therefore variable. So, in Proposition VI *De Libra*, he distinguishes between the weights H and G alone, and their "gravity", depending on their position in respect to the fulcrum A (cf. figure II.14, p. 359):

> The proportion between <the weights> H ad G is the same as the one between their gravities, *since they are attached in the same point* B. (...) Consequently CA is to AB, as the *gravity of the weight* H to the *gravity of the weight* G.[1]

But *gravitas* is not the only label that characterises a variable *effective heaviness* in the *Mechanicorum Liber*: for example, in the same passage of above, applying the law of the lever, Guidobaldo states:

> Fiat ut BA ad AC, ita pondus F ad aliud H, quod appendatur in B: pondera H, F ex A aequeponderabunt.[2]

The notion *aequeponderare* seems to be practically equivalent to "aeque gravia esse" or "*ponderare ut/quam*": this is testified, for example, by Proposition V *De Libra*. In its demonstration, Guidobaldo argues that two weights E and F, first fixed together in H, then in different points G and B, have the same effect as if they were fixed in one, certain point G in between:

> Pondera L, M ipsis E, F ponderibus in H appensis aequeponderabunt. Sed L, M ipsis E, F in G, B quoque aequeponderant: aeque igitur gravia erunt E, F in G, B, ut in H appensa. Tam igitur ponderabunt in B, G quam in H appensa.[3]

A minor variant is "essere gravis ut".[4]

[1] Cf. *Mechanicorum Liber*, fol. 35r: "Ut autem H ad G, ita est gravitas ipsius H ad gravitatem ipsius G, cum in eodem puncto B sind appensa. (...) Quare ut CA ad AB, ita gravitas ponderis H ad gravitatem ponderis G."

[2] Cf. *Mechanicorum Liber*, fol. 35r.

[3] Cf. *Mechanicorum Liber*, fol. 31r.

[4] Cf. *Mechanicorum Liber*, fol. 31v: "tam igitur gravia erunt pondera E, F in C, B quam in H appensa."

In the *Paraphrasis*, as well as in the "Letter to the Goth", Guidobaldo does not have recourse any more to the notion *gravity* in order to express the concept *proto-moment*: he generally expresses this concept with *aequeponderare*. A minor variation is "*aequaliter ponderare*" which, however, apparently possesses a slightly different nuance than *aequeponderare* for Guidobaldo, as the following passage of the "Letter to the Goth" documents:

> la libra (...)*manet* quand'ella non è equidistante all'orizonte, ne seguita che li pesi et ogni cosa *aequaliter ponderent*, donde si può dire, e si deve dire, che in quel sito *aequeponderant, quia alterum aequeponderant alteri*, altramente *aequaliter non ponderent*, et per consequenza *non manerent*. (...)

Beyond the use of *gravity* in the *Mechanicorum Liber* and *aequeponderare* in the *Paraphrasis*, with their respective variants, in the preface of the latter there is a certain use also of the notion *moment*. Its meaning oscillates between the basic and the figurative (mechanical) meaning. The respective passages and their contexts are the following:

> p. 1: "Alterum vero spectat ad ea, quae praeter naturam, et arte fiunt: quibus natura superari videtur (quamquam et ipsa plurimum momenti ad se ipsam evincendam tunc quoque afferat) et quod naturae viribus in lucem prodire nequit, id arte fieri contingat, (...)"
>
> p. 3: "Quorum quidem apparatus sunt artis opera, effectus autem ipsius paene[1] naturae: cum eius momenta inclinationesque sequantur, veluti praecipuas eiusmodi operum effectrices causas: (...)"
>
> p. 7: "Et quoad fieri potuit, verba omnia, quae nobis declaratione aliqua, nec non correctione indigere visa sunt (iis tamen omissis, quae parvi, immo[2] nullius sunt momenti, ut est litterarum immutatio, et huiusmodi alia) dilucide explicare, atque emendare studuimus."
>
> p. 9 [p. 17 for plane figures]: "Centrum gravitatis uniuscuiusque solidae figurae [plani] est punctum illud intra positum, circa quod undique partes aequalium momentorum consistunt."
>
> p. 9: "Ex quibus colligi potest, si grave quidpiam in centro mundi collocatum fuerit, oportere centrum gravitatis illius in centro mundi constitutum esse: siquidem ut grave illud tunc quiescat, partes undique ipsum ambientes aequalium momentorum exsistere, atque manere oporteat."
>
> p. 15: "Nam quamvis plana, quatenus plana sunt, nullam habeant gravitatem, non est tamen a rei natura, neque a ratione alienum, quin

[1] paene *correxi ex* pene
[2] immo *correxi ex* imo

possimus planorum, superficierumque centra gravitatis depraehendere, ex quibus si suspendantur, planorum partes undique aequalium momentorum consistentes maneant."

p. 16: "Si seorsum a corpore illud intelligamus, ut si ADC ex eius centro gravitatis G suspendatur, tunc quocunque modo reperiatur, hoc est sive horizonti aequidistans, sive minus, idipsum permansurum nihilominus intelligere possumus, partesque undique aequalium momentorum consistentes. Neque enim Aristoteles gravibus duntaxat, sed etiam levibus momenta tribuit, idipsumque (ut Eutocius in horum librorum comentariis refert) Ptolaemeo quoque placuit, ut habetur in libro (a nobis tamen desiderato) quem de momentis scripsit. Praeterea alii quoque philosophi id ipsum sensisse videntur. Quod est quidem rationi consentaneum, supervolant enim, quae levia sunt, et si mente concipiatur eadem figura levis cuiuspiam esse, tunc si detineatur in G, partes undique aequalium momentorum consistent, essetque G (ut ita dicam) centrum levitatis."

So, in the respective passages of pages 1 and 7 it signifies something like "importance", which corresponds with the basic meaning of the Latin "momentum".
In contrast, on pages 3, 9 (two times), 15, 16 (various times) and 17, it indicates the variable *effective heaviness*. Two of these passages (p. 9 and 17) are mere citations of Commandino's definition of *centre of gravity*, with its use of the notion *momentum*: Guidobaldo reports it twice, once of solids and then for the case of planes. Further, on page 16, he states that Ptolemy had written a book on *moments*, in the context of the existence of *light* bodies (in the Aristotelian sense).
But then, he includes the notion *moment* also in his own argumentations, although he was aware of the fact that the concept was not defined, nor its properties specified:[1] on page 3, he attributes "momenta inclinationesque" to weights fixed on the mechanical machines; on page 9, he explains that a body, once reached the centre of the world, takes such a position that its parts consist of *aequalium momentorum*, in order to guarantee there the immobility of any *heavy* body.

All in all, on the basis of the presented citations relative to Guidobaldo's terminology concerning the *proto-moment*, it can be concluded that he does not introduce a distinct, autonomous denomination compared to the transmitted Archimedean text, as in contrast did Maurolico and Galileo. He presents an incoherent use of various other notions: particularly *gravitas* in the *Mechani-*

[1] In fact, he practically negates the *status* of definition to Commandino's definition , saying (cf. *Paraphrasis*, p. 9): "Hanc postremam definitionem, seu potius descriptionem, tradidit Federicus Commandinus in libro *De Centro Gravitatis Solidorum*".

corum Liber which he abandons, though, in the *Paraphrasis* in favour of the predominating *aequeponderare*.

The concepts *manere*, *quiescere* and *aequilibrium*

In Guidobaldo, the notion "*aequilibrium*" does *not* compare, apart from two exceptions in his manuscript notebook *Meditatiunculae*. There, further, it seems to designate the horizontal position of the balance beam, more than the state of immobility: considering respectively the balance of stable and unstable equilibrium and their behaviour after a displacement from the horizontal, Guidobaldo states:

> Libra horizonti aequidistans, spartum habens sursum, cum mota fuerit, in aequilibrium horizonti aequidistans redit.
>
> Si verso libra habet spartum deorsum, non redit in aequilibrium, sed deorsum tendit.[1]

Interestingly, in the Italian translation of the *Mechanicorum Liber*, Pigafetta inserts an explication of the term, in difference to Guidobaldo:

> Dove si legge questo vocabolo latino "equilibrio", intendasi per eguale contrapeso, cioè che pesa tanto da una banda, quanto dall'altra in pari lance o libra o bilancia che si dica.[2]

This addition does not seem to be dictated by Guidobaldo, which would constitute a rare, and therefore an even more remarkable fact. Yet, Pigafetta's explanation seems to refer to the simple case of a balance of equal arms and would consequently be unsuitable for the general case.
The notion with which Guidobaldo expresses the state of immobility generally is *manere*: so, the first proposition of the *Mechanicorum Liber* states:

> Si pondus in eius centro gravitatis a recta sustineatur linea, nunquam manebit, nisi eadem linea horizonti fuerit perpendicularis.[3]

Besides *manere*, he seldom uses as well the expression *quiescere* which seems to be equivalent to *manere*: speaking of the properties of the barycentre, Guidobaldo claims:

> Quandoquidem centrum gravitatis talis est naturae, ut si mente conscipiamus, rem aliquam in eius centro gravitatis appensam esse, eo prorsus modo, quo reperitur, quiescat et maneat.[4]

[1] Cf. *Meditatiunculae*, p. 30. For further information, cf. Part A, VI.2.1.
[2] Cf. *Le Mechaniche*, fol. 29r.
[3] Cf. *Mechanicorum Liber*, fol. 3r.
[4] Cf. *Paraphrasis*, p. 15.

Obviously – it is advisable to emphasise this – *manere* and *aequeponderare* are *not* synonyms:

> Omnia nimirum, quae aequeponderant, manent. Sed non e converso, quae manent, aequeponderant.[1]

II.4.5 A résumé of Guidobaldo's approach

Let us, in this subsection, come to a synthesis of what Guidobaldo's Theory of Equilibrium was, on the basis of the analysis of his writings.
First of all, it is remarkable that Guidobaldo does not address the problem to construct a coherent Theory of Equilibrium in a specially arranged context of an autonomous writing or chapter dedicated to this topic: rather, he approaches it in a letter, as reply to a critique of his theory of indifferent equilibrium; in connection with the explanation of the Roman balance; and in the comments on Archimedes's *Equilibrium of Planes*: this is a significant difference to Maurolico, for example, who dedicated an entire work to the systematisation of the Archimedean Theory of Equilibrium. Guidobaldo's behaviour in this regard might suggest that the question assumed a secondary importance in his eyes.
The respective statements lead to the following résumé:

In the *Mechanicorum Liber* there are two different approaches to express the varying effectiveness of weights: the first one, exposed in the digression of the fourth proposition of *De Libra*, measures the variable effect of a body according to the inclination of the balance arm to which it is fixed. In this context, Guidobaldo has recourse to the idea of distinguishing different components of motion (a *natural* and an *unnatural* one) and of considering moreover converging lines of action. We might call this an "Aristotelian" approach to the question.

The second one, exposed in the sixth proposition of *De Libra*, refers to the horizontal balance beam. Guidobaldo states proportional dependencies of the three key concepts *weight*, *distance* and *proto-moment*. He explicitly proves the first two proportionalities; the third one, in contrast, is simply stated and used, without demonstration.

$$\begin{aligned} (w): &\quad m \propto d \\ (m): &\quad d \propto 1/w \\ (d): &\quad m \propto w \end{aligned}$$

These three relations, in the context of the Euclidean Theory of Proportions, are necessary and sufficient to demonstrate that *moment* is the composed relation of *weight* and *distance* – i.e. the quantitative description of the idea of *effective heaviness*. Interestingly, Guidobaldo does not approach this (technically rather easy) conclusion.

[1] Cf. *Paraphrasis*, p. 45.

The *Paraphrasis* does not furnish new elements in this direction. There, Guidobaldo rather puts emphasis on the explanation of the logical dependencies of the basic notions of the Archimedean Theory of Equilibrium, i.e. *manere*, *aequeponderare* and *centre of gravity*. Further, he offers a description, in the best case a definition, of the concept *aequeponderare*.
As the reciprocal logical relations between the basic notions are concerned, he distinguishes two cases: the one of the isostatic balance (not in vertical position!), which is, according to Guidobaldo, the one dealt with by Archimedes in the *Equilibrium of Planes*, and therefore the most important case in order to formalise the Theory of Equilibrium. The respective implications for the first case can be gained from the citations reported below:

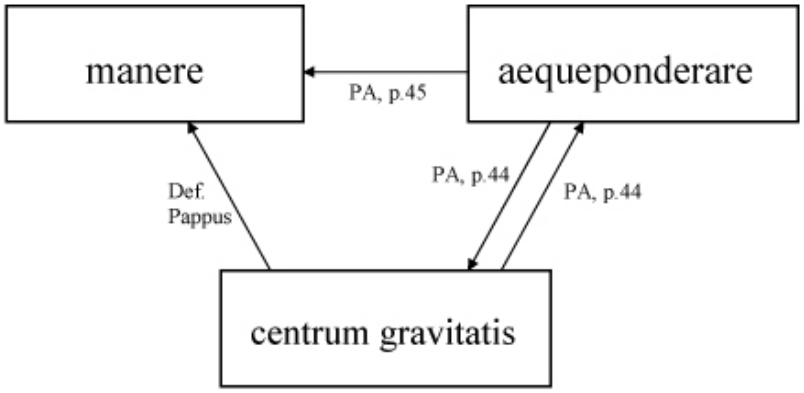

Figure II.19: The reciprocal logical dependencies of the basic concepts of Guidobaldo's Theory of Equilibrium, in the case of the isostatic balance; "PA" indicates *Paraphrasis*.

The Pappian definition clears the dependency of the notion *manere* (not of *aequeponderare* !) from the one of *centre of gravity*.[1] Next, the equivalence of the concepts *centre of gravity* and *aequeponderare* is expressed by Guidobaldo with the following words:

> If we say "the weights A, B suspended from C equiponderate" we can immediately infer that the point C is the barycentre of these weights together, i.e. of the magnitude composed by A, B. And on the contrary: "this point is the centre of gravity of these weights" consequently these weights equiponderate from this point.[2]

[1]For the wording of Pappus's definition, cf. footnote 1 on page 275.

[2]Cf. *Paraphrasis*, p. 44: "Si diciamus, gravia A, B suspensa ex C aequeponderant, statim inferre possumus, punctum C ipsorum simul gravium, hoc est magnitudinis ex ipsis A, B compositae, centrum esse gravitatis.Quare ad se invicem convertuntur: hoc punctum est horum gravium centrum gravitatis (...)." After this passage, Guidobaldo emphasises that this logical

The dependence of *manere* from *aequeponderare* can be deduced from what he exposes a little later:

> All <objects> that equiponderate, stay at rest.[1]

As far as the general case is concerned, the schema is somewhat different:

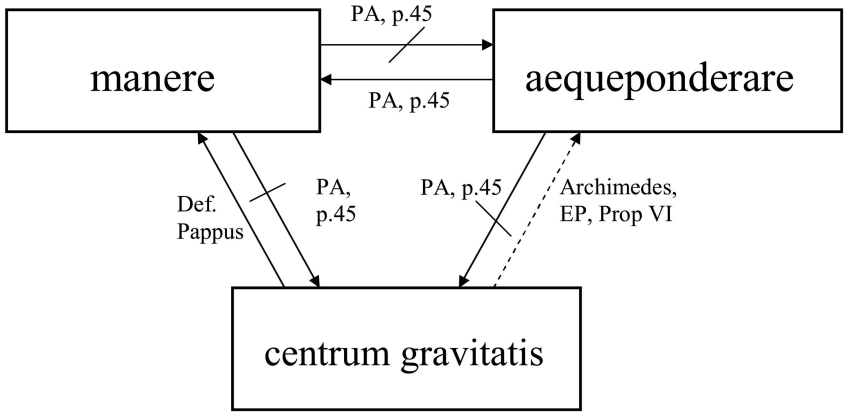

Figure II.20: The logical relations in the general case; "EP" indicates *Equilibrium of Planes*.

Compared with the special case of the isostatic balance, three implications do not hold generally, exemplified by Guidobaldo with an angular balance and a vertical isostatic balance: the one of *manere* to *aequeponderare*, of *manere* to *centre of gravity* and of *aequeponderare* to the *centre of gravity*. The following statements are all exposed on p. 45 of the *Paraphrasis* in the context of the explanation of Archimedes's "modi argumentandi":

> Omnia nimirum, quae aequeponderant, manent, sed non e converso quae manent, aequeponderant.
>
> *E*t quamvis magnitudo ex ipsis A, B composita ex E suspensa maneat, non propterea sequitur ergo E centrum est gravitatis magnitudinis ex ipsis A, B compositae <cf. figure II.22>.
>
> Suspendatur autem pondera A, B ex D et aequeponderent. Non sequitur tamen, ergo D centrum est gravitatis magnitudinis ex A, B compositae <cf. figure II.21>.

equivalence does not hold in general, only in the case of the isostatic balance: "Sed advertendum hanc sequi convertibilitatem, quando praefatum punctum est in recta linea, quae centra gravitatum ponderum coniungit, deinde quando haec linea non est horizonti perpendicularis. Secus autem minime." This aspect is dealt with below.

[1] Cf. *Paraphrasis*, p. 45: "Omnia nimirum, quae aequeponderant, manent."

So, all in all, in the *Paraphrasis* Guidobaldo has partly cleared the relations between *manere*, *equiponderation* and *centre of gravity*, but not entirely.

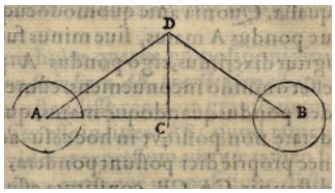

Figure II.21: An angular balance ADB, held in D.

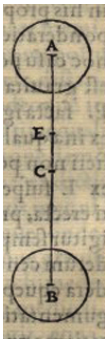

Figure II.22: The isostatic balance in the vertical position.

Further, the implication from *centre of gravity* to *aequeponderare*, signed by the dashed line in figure II.20, can be gained from Archimedes's demonstration of the law of the lever.[1] While the statement of the proposition refers to the *equiponderation* of two weights (with gravities inversely proportional to their distances from the fulcrum), the prove shows that the point, dividing the line between the two weights in the way that there is inverse proportionality between distances and weights, is the *centre of gravity* of the composed magnitude. If the demonstration is valid and complete, from the fact that a point is the barycentre of a system of two weights follows that they consequently equiponderate in respect to his point.

Finally, the "Letter to the Goth" (1598) furnishes ulterior interesting details about Guidobaldo's theory. Firstly, he apparently did not want to limit his conception of equilibrium to the exclusive case of the horizontal balance beam: this would not be compatible with the (Pappian) definition of centre of gravity and, further, it would be preferable to establish mathematical theories as universal as possible.
Moreover, he states twice in the letter that the concept *manere* implies the one of *aequeponderare* - this would be in contradiction to what he had stated in the *Paraphrasis* ten years before (cf. figure II.20). Certainly, we should not overemphasise this fact: it might have been a simple lapse, potentially due to low concentration while he wrote the letter in question. Further, in 1598, Guidobaldo seems to have principally abandoned his studies on mechanics in favour of the works on perspective; therefore, he might not have remembered well.

[1] Obviously only on the condition that the demonstration of the sixth proposition has not been corrupted. Cf. J.L. Berggren, *Spurious Theorems in Archimedes' Equilibrium of Planes Book I*, cit.

On the other side, however, the letter might be a clue that Guidobaldo himself possibly was doing a bit of confusion with the basic notions of the Theory of Equilibrium: in fact, as has been exemplified in II.3.1 (p. 349), it is very easy to end up in a vicious circle.

II.4.6 Possible conceptual obstacles against a complete formalisation of Guidobaldo's Theory of Equilibrium

The last subsections have revealed some problematic aspects of Guidobaldo's Theory of Equilibrium. In this context, the present section intends to analyse two crucial elements of his mechanics that seem to be just barely compatible with a formalisation of his theory: the consideration of converging lines of action on the one hand, and his discovery of indifferent equilibrium on the other. The results of these analyses shall contribute to clarify to which extent they constituted an obstacle for Guidobaldo to completely formalise his Theory of Equilibrium.

The problem of converging lines of action

As exposed in II.4.1, Guidobaldo presents in the *Mechanicorum Liber* two completely different approaches to measure the varying effectiveness of a weight, which we could call, respectively, an "Aristotelian" and "Archimedean" approach: could they be integrated in an coherent theory, and if possible *how*? The main problem of this question is connected with the convergence of the lines of action, recurred to in the Aristotelian approach.
Guidobaldo introduces this conception as *argumentum ad hominem* against Tartaglia: the latter, on the one hand, had postulated converging lines of action in his axioms,[1] but on the other, he had shown the impossibility of indifferent equilibrium using *parallel* lines of action.[2] So, Guidobaldo took up this conception in order to show that, if Tartaglia had applied it to his argumentation concerning the isostatic balance, his "proof" of the impossibility of indifferent equilibrium would not have held.
Then, however, after his counter against Tartaglia, the Marchigian mathematician applied this conception to other questions, for example to the problem of measuring the varying effectiveness of a weight attached to a rotatable beam (cf. figure II.25). He develops the problem, already approached by Jordanus and Cardano, much further so that it assumes the characteristics of an autonomous topic, independent of his opponents' contrasting opinion: in fact, Guidobaldo

[1] Tartaglia, in the first postulate of the eighth book of *Quesiti et Inventioni diverse*, explicitly states: "Adimandamo che ne sia concesso, che il movimento naturale de ogni corpo ponderoso e grave sia rettamente verso il centro del mondo." Also Jordanus had postulated this fact, cf. *Elementa*, axiom I: "Omnis ponderosi motum esse ad medium."

[2] Cf. Part B, I.1.1.

must have held his respective theory in high esteem and made Pigafetta emphasise this passage in an appeal to consider it with the "highest attention".[1]
From this perspective, it would seem that the conception of converging lines of action did not remain an *argumentum ad hominem*, but that Guidobaldo was sympathetic to this idea – comprehensively, since it could be interpreted as deriving, in the end, from the Aristotelian natural philosophy (with its conception that any body tends to get back to its natural place) and from the *Quaestiones Mechanicae* (the distinction of a *natural* and an *unnatural* motion) which he held in high estimation.[2]

Yet, the consideration of converging lines of action implies serious problems of incompatibility with other elementary aspects of Guidobaldo's mechanics:
First of all, the very concept of *centre of gravity* is not well-defined if the lines of action of the weights are not supposed to be *parallel*. This fact can be simply illustrated by the following figure II.23:
Let A, B be equal weights in equal distances from the fulcrum on a horizontal balance beam, it would have to stay at rest if the lines of action were supposed to be parallel. If, in contrast, an inhomogeneous gravitational field is taken into consideration with non-parallel lines of action, like AS and BS, so the weights do *not* necessarily stand still: in fact, their torsional moments $\overrightarrow{M}_{A/B} = \overrightarrow{F}_{A/B} \times \overrightarrow{r}_{A/B}$ are not equal:

$$\overrightarrow{F}_A \times \overrightarrow{r}_A = F \cdot r \cdot sin(90°) = F \cdot r = m \cdot g(\overrightarrow{x}) \cdot r,^3 \text{ and}$$
$$\overrightarrow{F}_B \times \overrightarrow{r}_B = F \cdot r \cdot sin(\beta) = m \cdot g(\overrightarrow{x}) \cdot r \cdot sin(\beta)$$

So, the torsional moment of the weight in B is smaller than the one of A. Consequently, even if the system is held in C – according to the "standard" definition of the barycentre of the system – it does not stand still, but moves. Consequently, the concept of *centre of gravity* changes its properties radically compared to the case of parallel lines of action.

Also Guidobaldo's theory of indifferent equilibrium would not be valid in an inhomogeneous gravitational field, in particular not in a field with converging

[1] Pigafetta wrote what Guidobaldo had dictated him, cf. *Le Mechaniche*, fol. 29r: "Et percioché egli <il discorso dopo Prop. IV *De Libra*> contiene cose di altissima speculatione, massimamente d'intorno al considerare dove sia più grave un peso solo posto in uno bracco della bilancia, bisogna in ogni modo, per bene intendere, leggerlo et istudiarlo con accuratissima diligenza."

[2] For further information about Guidobaldo, his occupation with Aristotelian natural philosophy and his philosopher-interlocutors, cf. Part A, V.1.2 and V.2.4. Anyway, Guidobaldo's opinion about parallelism or convergence of the lines of action seems to be somewhat incoherent: a detailed analysis of this aspect is exposed in Part A, IV.2.3.

[3] Here, g designates the gravitational factor. As an inhomogeneous gravity field is considered, its value depends on the place $\overrightarrow{x}$, where the respective weight is located.

lines of action (cf. figure II.24): let us consider an inclined isostatic balance, with equal weights M, N from equal distances r_M and r_N, and converging lines of action MS, NS, so the torsional moments of the weights will not be equal, in general. In fact, imagine the case of $\gamma = 30°$ and $\nu = 120°$.[1] Consequently μ is 30°, too. With the formula from above, we have:

$$M_{N/M} = \overrightarrow{F}_{M/N} \times \overrightarrow{r}_{M/N} = F_{M/N} \cdot r_{M/N} \cdot sin(\mu/\nu).$$

Since $sin(\nu = 120°) = \sqrt{3}/2$ and $sin(\mu = 30°) = 1/2$, the torsional moments are *not* equal, the balance does *not* stand still. So, generally there is no indifferent equilibrium.
Guidobaldo could not have agreed with such a consequence, which would have contradicted one of the cores of his mechanics.

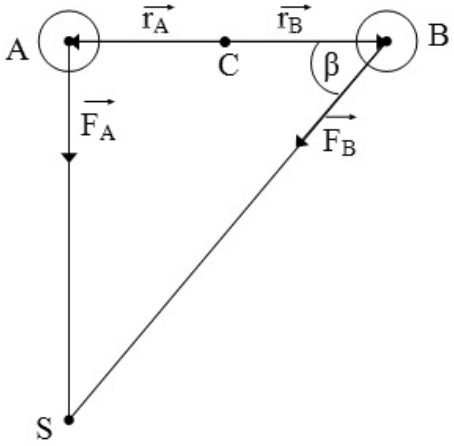

Figure II.23: Most elementary facts of mechanics, as the equilibrium of equal weights in equal distances, are not true assuming a inhomogeneous gravitational field, symbolised by the forces $\overrightarrow{F}_A$ and $\overrightarrow{F}_B$.

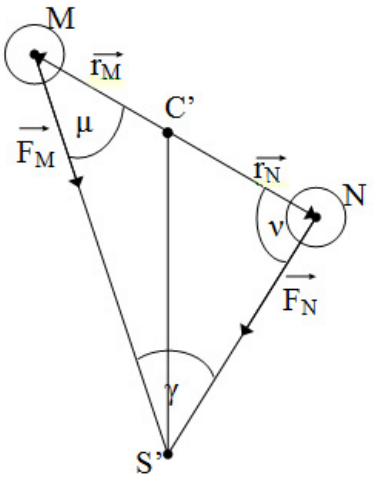

Figure II.24: The isostatic balance in a converging gravitational field: Guidobaldo's theory of the indifferent equilibrium would not be valid any more.

Besides, there is another critical point: Guidobaldo had argued, that a weight, according to the inclination of the balance beam to which it is fixed, varies its *effective heaviness*: it is positionally heaviest when it is in the position O – O is the contact point of the tangent from the centre of the world with the circle described by the weight on the rotating balance arm (cf. figure II.25).
Moreover, the position of the point O additionally varies, according to Guidobaldo,

[1] The aperture angle γ at S' (the centre of the world) depends on the distance of the balance to it, so it can be chosen freely in this example.

with the distance of the between the circle and the centre of the world (cf. figure II.26).[1] So, how should this aspect be combined with the fact, that, for a fixed inclination, the *effective heaviness* was depending on the weight and the distance of the respective body from the fulcrum? A quantitative mathematical model that takes into consideration of all these facts would be highly complex and difficult to construct even with the modern mathematical instruments.

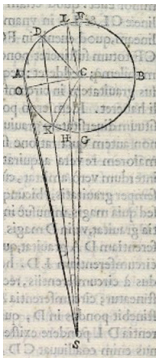

Figure II.25: The varying effective heaviness of a weight attached to a rotatable balance arm.

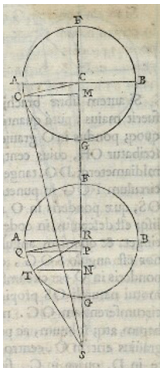

Figure II.26: The variation of the position of the contact point O (and T in the second case).

Guidobaldo's discovery and defence of the indifferent equilibrium

As the precedent sections have evidenced, Guidobaldo had at his disposal a definition of *centre of gravity* and gives a description also for *aequeponderare*, that could optimistically be interpreted as definition, even if it is not denominated as such. Yet, the third involved basic concept, *equilibrium* or (in his terminology) *manere*, is not defined. This, again, might seem quite unnecessary, as it is a very intuitive notion: in contrast, let us again refer to the vicious circle exposed in II.3.1 (p. 349), that derives from the unclear logical relations between the basic notions, going back to their missing definitions.

In effect – taking Maurolico's Theory of Equilibrium as comparative example, again – in the approach of the Sicilian mathematician the equilibrium of the balance is defined, namely as the horizontal position of the balance beam.[2] On this basis, he succeeds in creating a mathematically formalised model of *moment*, obviously regarding equilibrium as *stable*.

[1] For a detailed description of Guidobaldo's reasoning, cf. Part A, IV.2.2.

[2] The eleventh definition of Maurolico's *De Momentis aequalibus* reads: "Gravia vero aeque pondere, seu aeque ponderare dicuntur, cum ab aliquo puncto appensa ita pendent, ut recta quae gravitatum centra, vel appensionum puncta, coniungit horizonti aequi distet." So, Maurolico defines the concept *aequeponderare* by the properties of the other basic concept *equilibrium*: he can do this, since *equiponderation* of weights implies their *equilibrium*.

Yet, in the "Letter to the Goth", Guidobaldo harshly rejects any Theory of Equilibrium that relates the concept *proto-moment* or *equilibrium* to the parallelism of the beam to horizon. In effect, a way similar to Maurolico's was not acceptable for the Marchigian mathematician, for several reasons: firstly, in his opinion, Archimedes had considered isostatic balances, as he deduces from a passage of the fourth proposition of the *Equilibrium of Planes*: consequently, the reconstruction of his theory would have to refer to exactly this kind of balance.[1] Secondly, the only antique definition of *centre of gravity* stemmed from Pappus: its inclusion by Guidobaldo in his theory seems comprehensive, as it is one of the basic concepts of Archimedes's mechanics, whose extant *corpus* does/did not transmit any. An immediate conclusion of this definition is the indifferent equilibrium of the isostatic balance. Thirdly, Guidobaldo seems to have been generally interested in setting up his mathematical theories as general and universal as possible. Therefore, once comprehended the existence of the indifferent equilibrium, he could not ignore it by adopting a definition like Maurolico's.

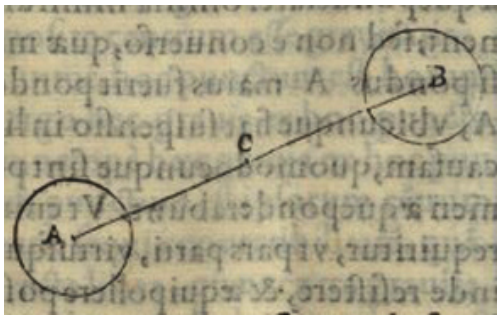

Figure II.27: The indifferent equilibrium of the isostatic balance.

Now, while stable equilibrium is easy to define – with an external[2], geometrical property, namely the parallelism of the balance beam to horizon –, indifferent equilibrium does not offer this possibility. It seems that it cannot be described by an external property, neither geometrically (a balance in indifferent equilibrium can assume any inclination), nor physically without drawing on the other two basic notions *centre of gravity* or *equiponderation*.
Yet, without such a reference to these notions, it tends to explain itself, in a circular way, along the lines of: "indifferent equilibrium is, when the weights stand still, i.e. when nothing moves, namely when there is equilibrium". Further, this

[1] Interestingly, none of the modern attempts to reconstruct Archimedes's Theory of Equilibrium (Vailati, Stein, Drachmann, etc.) takes into consideration Guidobaldo's theory of indifferent equilibrium, although there are hints in the Archimdean writings that the Syracusan mathematician knew about this kind of equilibrium (cf. Prop. IV *Equilibrium of Planes*, Prop. I *Method*).

[2] "External" means, that it has recourse to a condition that does not depend on the other basic concepts of the Theory of Equilibrium, *centre of gravity* and *proto-moment*.

circular reasoning shows that another possibility of defining indifferent equilibrium might be to bring it in relation with the concept of *motion* – but this turns out to be problematic as well: it would be an alien element in Guidobaldo's "Archimedean" approach; given his high fidelity to the contents of the *Equilibrium of Planes*, this method seems to have been precluded for the Marchigian mathematician.[1]
So, it appears that the only possibility to define indifferent equilibrium is to relate it with one of the other two basic notions, *centre of gravity* or *equiponderation*. As the concept *centre of gravity*, in its Pappian definition, is already characterised by the notion of *equilibrium*, the indifferent equilibrium cannot be defined, on its part, by having recourse to the barycentre. So it would have to be put into relation with *equiponderation*. But this would be more than problematic: the conceptual task of the concept of *proto-moment* (or *equiponderation*) is to clear the conditions under which there is *equilibrium*: this derives from the fact that the physical magnitude *weight* generally does not suffice to clear the (geometrical, physical etc.) circumstances of equilibrium. Precisely this was the reason why notions like *aequeponderare* or *momentum* had to be introduced in theoretical argumentations. But if, from the very beginning, the notion of (indifferent) equilibrium is characterised or defined by the *proto-moment*, the whole theory risks to become circular.

Guidobaldo seems to have met a similar problem: as II.4.2 has evidenced, in the *Paraphrasis* the notion *aequeponderare* logically implies the one of *manere*, i.e. equilibrium, while the contrary is claimed not to be valid.[2] In the "Letter to the Goth", in contrast, the Marchigian mathematician twice states the other logical implication: *manere* would implicate *aequeponderare*.[3]
In fact, this circular reasoning seems to indicate an implicit characterisation of *equilibrium* by *equiponderation*, like: "equilibrium is, when the weights in question equiponderate". A similar conception obviously is equivalent to the logical implication from *manere* to *equiponderation*, but it would be in contradiction

[1] In reality, the idea of movement seems to be contained in the first three axioms of the *Equilibrium of Planes*. But generally, the notion *motion* does not have any function in the writing. As J.L. Berggren has further pointed out, exactly the first three axioms (as also the first three propositions) seem to be spurious.

[2] Cf. *Paraphrasis*, p. 45: "Omnia nimirum, quae aequeponderant, manent, sed non e concerso quae manent, aequeponderant."

[3] Cf. the "Letter to the Goth"; the first passage in question reads: "la libra (...) *manet* quand'ella non è equidistante all'orizonte, ne seguita che li pesi et ogni cosa *aequaliter ponderent*, donde si può dire, e si deve dire, che in quel sito *aequeponderant, quia alterum aequeponderant alteri*, altramente aequaliter non ponderent, et per consequenza non manerent." The second one is: "<Archimede>, come anche in tutti due quei libri, non nomina mai l'equidistantia all'orizonte, che di questo *ne verbum quidem*, che trattando sempre del centro della gravità quando li pesi sono sostenuti in quello, vuole che in ogni sito *maneant ac per consequens aequeponderent*."

to Guidobaldo's statement in the *Paraphrasis*: if both logical implications were right, the concepts *equilibrium* and *equiponderation* would be equivalent, and this is, at least according to Guidobaldo's explicit statement in the *Paraphrasis*, not acceptable.

So, conclusively, it seems plausible that the conceptual difficulty, with which the indifferent equilibrium is to handle, might have provoked the contradiction between the respective passages of the *Paraphrasis* and the "Letter to the Goth", regarding the two concepts of *equilibrium* and *proto-moment*. Not having at his disposal a satisfactory definition of indifferent equilibrium – the only kind of equilibrium acceptable to reconstruct Archimedes's Theory of Equilibrium, in Guidobaldo's eyes – he seems to have drawn on the concept *aequeponderare* for a characterisation of it, which implied a circular reasoning.
Yet, it seems that the contents of the *Paraphrasis* have to be considered as more reliable for Guidobaldo's convictions: the elaboration of the work extended over several years, whereas the "Letter to the Goth" was probably written within a day, possibly in a hurry: his statement in question also be a mere confusion. But obviously, even if we would concede this possibility, also the mere fact of a conceptual confusion is informative in regard of the question how exactly Guidobaldo had understood and formalised his Theory of Equilibrium.
A final aspect seems to be noteworthy: the various passages in which Guidobaldo makes statements about the Theory of Equilibrium are chronologically far apart: *Mechanicorum Liber* (1577), *Paraphrasis* (1588) and the "Letter to the Goth" (1598) were respectively separated by a decade. In the meantime, Guidobaldo seems to have been occupied by studies on completely different mathematical branches like astronomy, perspective, not to speak of the numerous "extra-scientific" activities he was obliged to carry out. This seems to be one factor that explains some incoherences, in respect to the terminological level, but also to the logical connections of the basic notions in question.

II.5 Conclusions

It is finally time to come to the conclusions and interpretations, on the basis of what has been exposed in the present chapter: starting from P. Galluzzi's hints at elements of Guidobaldo's Theory of Equilibrium,[1] the respective passages in the Marchigian mathematician's writings have been tracked down and analysed, with the intention to enrich our knowledge about this relevant aspect of Guidobaldo's mechanics.

Shortly recapitulating the most important elements of the present chapter, Guidobaldo does not dedicate one, single work (exclusively) to address the question – in difference to Maurolico and, to some extent, Galileo. He approaches it substantially three times, once in the *Mechanicorum Liber*, published in 1577, then in the *Paraphrasis* (1588) and finally in the "Letter to the Goth", written in 1598.
In the *Mechanicorum Liber*, he proves two of three necessary relations that would have permitted him to characterise the weights' *varying effectivness*, in the context of the Euclidean Theory of Proportions, as composed relation (i.e. product, modernly spoken) of *distance* and *weight*. The third relation is stated, but not proved - yet, its demonstration is analogous to the other two, so Guidobaldo might have regarded it as trivial. Interestingly, though, he does not use these three relations to state the quantitative dependence of the concept *proto-moment* from *weight* and *distance*: as the demonstration of this fact would not have presented technical difficulties, this behaviour suggests that Guidobaldo did not regard the mathematical formalisation of this concept to be an urgent priority.
In the *Paraphrasis*, the Marchigian mathematician attends to the explanation of the conceptual relations between the three Archimedean basic concepts of the Theory of Equilibrium, namely *equilibrum*, *aequeponderare* and *centre of gravity*. He succeeds in stating their reciprocal interrelation in the special and important[2] case of the isostatic balance. As far as the general case is concerned, he does not specify all relations.
In the "Letter to the Goth", he seems to partly contradict what he had written ten years before in the *Paraphrasis*, as far as a logical implications between the basic notions is concerned.

So, all in all, it seems evidenced that Guidobaldo did not furnish a mathematical formalised Theory of Equilibrium – he does not seem to have had this intention. And obviously, his theory does not contain important elements of the concept *moment* as it is intended in modern physics, like the conception of a direction-dependency of force.

[1] Cf. P. Galluzzi, *Momento. Studi galileiani*, cit.

[2] According to Guidobaldo, it is the isostatic balance that Archimedes took into account as model for his considerations.

But on the other hand, it cannot be ignored that he made distinct efforts to create a geometrical, axiomatic theory based on the Archimedean concepts: meaningful, in this context, are the statements of the *Communes Notiones* of the *Mechanicorum Liber* according to the model of Euclid's *Elements*, the inclusion of Pappus's barycentre-definition and the explication of important logical relations between the basic notions in the *Paraphrasis*.

Against the background of these efforts, but also of the limits of this theory, the question arises what might have been the reason(s) for the incompleteness of his approach. A mathematical formalisation of the concept *moment*, as created by Maurolico, or at least the identification of the important role of the *proto-moment* (as, e.g., in Galileo) does not seem to have been out of reach for Guidobaldo's mathematical abilities.
In this regard, a glance at his occupation with other mathematical disciplines is helpful: the Marchigian mathematician succeeded in setting up a geometrically formalised theory of perspective (in the *Perpectivae Libri sex*), by establishing a mathematical theory of the concept of *vanishing point* and by proving its mathematical properties; to the point that he is considered "to be the father of the mathematical theory of perspective".[1] So, against this background, his incomplete treatment of the Theory of Equilibrium is even more puzling, considering further that his theory seems to possibly contain a logical incoherence.
Precious information that appears to clarify this problem is contained in the "Letter to the Goth", where Guidobaldo states:

> But perhaps the Goth means that I have used this term <of *aequeponderare*> wrongly. But this would not be serious, *because the terms, in the end, have to be interpreted in the way in which they have been used by the <ancient> authors.*[2]

This passage suggests that Guidobaldo, in this question, was not interested in a creation of a new theory, although Archimedes's Theory of Equilibrium did present various problematic points – he seemed to be mainly interested in the explication of the elements that had remained. This conception precluded him the way of introducing a new concept that might have been easier to treat. This hypothesis would explain both his indifference towards characterising weights' *effective heaviness* as composed relation of *weight* and *distance*, and on the other hand his efforts to clear the doubtlessly problematic Archimedean theory.

[1] Cf. K. Andersen, *The Geometry of an Art*, cit., p. 237: "For reasons soon to be explained, I consider Guidobaldo del Monte to be the father of the mathematical theory of perspective and hence pay considerable attention to his work. It is natural to take up Simon Stevin's work on perspective in connection with Guidobaldo, since Stevin's contributions are a direct continuation of some of Guidobaldo's accomplishments."

[2] Note the close connection, particularly in the Middle Ages and in the Renaissance, between the terms *author* and *authority*. The emphasis is ours.

This problematic situation was accompanied and aggravated by certain elements of his own mechanics: while the (somewhat incoherent) conception of converging lines seems to have been a solvable question, his discovery of the existence of indifferent equilibrium posed a serious conceptual problem that he apparently was not able to solve.

From this perspective, it seems plausible that it principally was the respect for Archimedes's mechanics that restrained, or at least contributed to restrain Guidobaldo from developing a mathematically formalised Theory of Equilibrium. His conception of equilibrium as *indifferent* would have been a serious conceptual problem for the establishment of a coherent theory based on the Archimedean basic notions, but this does not explain his indifference towards the mathematical formalisation of the weights' varying *effective heaviness*, interrupted halfway in the *Mechanicorum Liber*.
While he apparently perceived the necessity to create a mathematical model of the concept *vanishing point* in perspective – a mathematical field not treated by Greek mathematicians, let alone by Archimedes himself: the first written account of geometrical perspective is L.B. Alberti's *De pictura* (1435) – he acted differently in regard of his occupations with the Archimedean Theory of Equilibrium: as far as it seems, he did not want to go (to far) beyond the traditional frontiers of this antique discipline.[1]

[1] A somewhat similar situation is presented by his approach to explain the Euclidean theory of the composed relation, contained in the manuscript BOP, ms 631: also in this case, his respect towards the Euclidean tradition is clearly perceptible. In contrast to Benedetti or Galileo, he did not introduce substantial novelties in this theory, despite of the problems it posed for the establishment of mathematical models of composed physical magnitudes (like velocity, specific weight, moment, etc); cf. P.D. Napolitani, *Sull'Opuscolo* De Proportione composita *di Guidobaldo dal Monte*, Pisa, Università di Pisa, 1982; and E. Giusti, *Euclides reformatus*, cit.

Part C

Conclusions, interpretations, perspectives

Conclusions, interpretations, perspectives

The present, final part exposes the main conclusions that can be drawn on the basis of the researches conducted in the context of this doctoral thesis, with its two-pronged approach based both on studies of Guidobaldo's correspondence and cultural environment, as well as on the analysis of his principal writings. Four principal results about Guidobaldo's mechanics and the context of his work seem to be particularly noteworthy: the close connection between his scientific work and the scientific-technical environment of the Duchy of Urbino; the distractions from a more systematic treatment of mechanics: his numerous "extra-scientific" duties and his occupation with other mathematical branches; aspects of Guidobaldo's "program" of mechanics; and, finally, the fundamental role of the discovery of the indifferent equilibrium for his mechanical theory.

The close connection between Guidobaldo's scientific work and the scientific-technical environment of the Duchy of Urbino

Imprecise or even fallacious elements about Guidobaldo's biography are still circulating, many of them going back to seventeenth- and eighteenth-century sources whose reliability is unclear. The researches conducted in the context of this doctoral thesis could contribute to clear several aspects of his life and work.
Emblematic for the previous situation is the still widespread belief that Guidobaldo would have realised his entire scientific work in isolation at Monte Baroccio. This information goes back to Baldi, but referred, as the collected documents prove, to a specific phase of Guidobaldo's scientific activity. In contrast, especially his early and mature period were characterised by regular, significant interactions and with the scientific-technical environment at Pesaro and Urbino. Baldi's information has hence been distorted. This new situation evidently implies a notable change of perspective: in fact, several aspects of his works could be traced back to the interaction with his scientific interlocutors and technical collaborators.
As the collected documents testify, Guidobaldo's scientific work was notably conditioned by his strong tie to Francesco Maria II della Rovere, both by the latter's requests of certain scientific treatises as well as by the numerous "extra-scientific"

tasks commissioned by the Duke (cf. below). Also Guidobaldo's pro-Aristotelian basic attitude, manifesting in several points of his work, might find an explication, or at least an important framework condition, by this context: important scientific interlocutors of him (C. Benedetti, F. Bonaventura, to some extent also J. Mazzoni) were proponents of the Aristotelian philosophy, which was held in estimation in the general cultural *milieu* of the della Rovere-court.
The fact of Guidobaldo's close connection with the Urbinate, until approximately 1590, court leads to a more general question: which role was assumed by the Renaissance courts and their scientific-technical environments in the preparation of important framework conditions for the scientific revolution of the seventeenth-century? In this regard, comparative studies of G.B. Benedetti's and S. Stevin's works with Guidobaldo's would seem useful for a better understanding of the problem: I intend to deal with this question in the near future.

So, besides his mathematical studies with Commandino, which reinforced his interest in Greek mathematics and contributed to his rather "conservative" approach towards the ancient theories, there can be identified substantially two other factors to be regarded as crucial for the formation of the young Guidobaldo: his strong tie to the ducal court with its rich cultural *milieu*, in which he grew up and whose characteristics left traceable elements in his work, and on the other hand his contacts with the world of the engineers, soldiers, and technicians, which offered inspiration and influenced his scientific activity. Each of the analysed writings *Mechanicorum Liber*, *Paraphrasis* and *Meditatiunculae* contains important elements that connect Guidobaldo theoretical work to his context: this is testified in the *Mechanicorum Liber* by the topic of the isostatic balance which was a high precision instrument, not at the disposal of the generality of the scholars of mechanics;[1] the *Paraphrasis* presents elements that seem to go back to reflections Guidobaldo could have made in interaction with his scientific interlocutors, among them philosophers of Aristotelian orientation;[2] finally, several entries on practical topics in the *Meditatiunculae* confirm the hypothesis of a close relation between Guidobaldo's scientific work and his activities as architect-engineer and constructor of scientific instruments. The same conclusion is valid for the presence of some questions on natural philosophy, against the background of his close contacts to philosophers as scientific interlocutors.

[1] In contrast, Urbino and Pesaro were centres of the fabrication of scientific precision devices which offered to the Marchigian mathematician the possibility to control his theory by direct experience – as he himself tells in a letter to Contarini, mathematical demonstration and practical experiences were inseparably related with each other, in his conception.

[2] Among these elements are a reasoning about light bodies (in the Aristotelian sense); the partition of mechanics in two equally relevant domains, namely mathematics and natural philosophy, with Archimedes and Aristotle as respective authorities; the justification of the central property of the *centre of gravity*-concept drawing on elements of the Aristotelian cosmology.

Guidobaldo's distractions from a more systematic treatment of mechanics: his numerous "extra-scientific" duties and his occupation with a remarkable number of other mathematical branches

Guidobaldo had assumed numerous activities "besides" his actual scientific work in a much higher degree as the hitherto known documentation had suggested. In reality, only at first glance they can be considered separated from his occupation with mathematics: they represent a relevant element of his complex scientific character. These occupations reached from military and hydraulic engineering, civil and religious architecture, over his roles as technical consultant of Francesco Maria II della Rovere and supervisor of the ducal clock-fabrication, to the ones as teacher of future engineers,[1] or as count of a largely autonomous community. All these occupations had more or less direct influences on his scientific work: on the one hand, they offered inspiration and led to reflections on his mathematical work (cf. above); on the other, they constituted distraction from it and seem to have been one of the factors that kept him away from a more systematic treatment of mechanics.

In fact, his mechanical theory interestingly contained some inconsistent elements. This concerns not only the question of parallelism or convergence of the lines of action; but also his Theory of Equilibrium, which seems to miss a complete logical and mathematical formalisation and an uniform terminology. Remarkably, the various passages in which Guidobaldo makes statements in regard are chronologically far apart: *Mechanicorum Liber*, *Paraphrasis* and the "Letter to the Goth" were respectively separated by ten years or more. In the meantime, apart from his numerous "extra-scientific" activities, Guidobaldo was obliged to carry out, he seems to have been occupied by intensive studies on completely different mathematical branches like astronomy and perspective.

There is another aspect of Guidobaldo's to keep in mind in this context: his notable interest and versatility in a conspicuous number of mathematical branches, which has found a precious testimony in the *Meditatiunculae*: there are entries on pure geometry, arithmetic, gnomonics, music, astronomy, optics, perspective and mechanics (including problems regarding natural philosophy). The generally abrupt alternation of mathematical problems concerning fundamentally different branches hints at the possibility that Guidobaldo's method of dealing with mathematics in this writing, was not always characterised by targeted researches on a determinate subject. Certain topics seem to be approached more by opportunity, probably thanks to exterior stimuli, than chosen following a defined scientific project.

[1] As far as Guidobaldo's instruction of future engineers and architects is concerned, the collected documents seem to testify that this activity was characterised by some regularity and coherence, plausibly instituted at the Duke's instance. This would mean that Guidobaldo, too, was the head of a school; its model was quite different, though, compared to Commandino's. A comparison of these two different teaching models and, more generally, in-depth studies on the "School of Urbino" would be welcome and useful for a better comprehension of the recovery of ancient knowledge and its transformation as foundation of modern science.

My proposal of a new dating of the manuscript is connected with this topic: the analysis of the mechanical entries suggests that the first part of the manuscript goes back to a much earlier period of Guidobaldo's work than to the period between 1586-1593, as the notebook is used to be dated traditionally. Many considerations and problems priorly considered as stemming from his mature phase, would have been approached, in contrast, already in his early scientific phase: *inter alia* his studies on the *Cochlea*, on the *Problematum astronomicorum Libri septem*, on the lost treatise *De Motu Terrae*, as well as his works on gnomonics and on the inclined-plane-problem. I will dedicate further researches on the dating problem in the near future.

Elements of Guidobaldo's "program" of mechanics

Even if Guidobaldo's theory of mechanics was characterised by some inconsistent elements, the comparative analyses of his writings seem to document that it followed a rather determinate program. Interestingly, this fact is connected with and opposed to two major critiques his writings have received by modern historiographers: his alleged blind admiration of ancient mechanics and his excessive mathematical rigour.

One of the elements of his mechanical program emerges from the *Mechanicorum Liber* and the successive debates on it: despite of the stimuli Guidobaldo (had) received due to his contact with the world of the technicians and to his experiences as soldier and engineer-architect, he refused a too strong orientation of mechanics towards practical questions. As he emphasised in a letter to Pigafetta, Vitruvius's model of mechanics is not worthy to be imitated, since its investigation was limited by a too technical approach. Given his rejection of the Vitruvian approach, the "blind-admiration-of-ancient-mathematics debate" does not seem to catch the point: it is true that Guidobaldo strongly orientated towards Archimedes's work; but not because the latter was a Greek mathematician, but because he dealt "*scientifically*" with mechanics (i.e. following a geometrical, axiomatic model) – in contrast to Vitruvius. Also another frequent critique of some historiographers of mechanics turns out to be misleading against this background: Guidobaldo would have critised medieval mechanics precisely for his orientation to Greek mathematics. His rejection of Jordanus's mechanics, however, was based on a well-founded scientific argument related to the treatment of the isostatic balance (cf. below): he had demonstrated that its very foundation principle, the *gravitas secundum situm*, was incompatible with Archimedes's mechanics. Moreover, this was the reason of his non-consideration of the inclined-plane solution of Jordanus.

The establishment of mechanics as part of natural philosophy seems to have been another trait of Guidobaldo's "mechanical program" and can be made out particularly in the *Paraphrasis*. Against the background of the biographical researches, testifying that some of his closest scientific interlocutors were philosophers of Aristotelian orientation, specific subjects in the preface seem to reflect

their common discussions. For example, the reasoning about light bodies (in the Aristotelian sense); the partition of mechanics in two equally relevant domains, namely mathematics and natural philosophy, with Archimedes and Aristotle as respective authorities; the justification of the central property of the *centre of gravity*-concept, by drawing on elements of the Aristotelian cosmology. The insertion of these topics in a mechanical treatise are part of Guidobaldo's attempt to embed Archimedes's mechanics in the framework of the Aristotelian philosophy, which goes, in my opinion, beyond a simple "Archimedean-Aristotelian synthesis" that has been suggested by the remarkable studies of van Dyck.
This project can be regarded as a general characteristic of Guidobaldo's mechanics, since its manifestations do not regard only the *Paraphrasis*, but also the *Mechanicorum Liber* (with the compromise regarding parallelism/convergence of the lines of action) and the *Meditatiunculae* (with the entries on bodies descending in a fluid and on the motion of Earth).
In this context, Guidobaldo's interpretation of Archimedean mechanics leads to a more general problem: how did the restoration of Greek mathematics took place in Renaissance and which were the characteristics of this appropriation procedure of ancient scientific models and ideas? Is it really true that it was an intellectually sterile, rather automatic process, as still influential conceptions *à la Duhem* suggest? Guidobaldo's project seem to confute this hypothesis: both his interpretation of Archimedes's mechanics as implying a conception of equilibrium as an indifferent one, and its embedding in the Aristotelian natural philosophy go – in crucial points – far beyond the actual content of the Syracusan's theory. Guidobaldo adapted these elements decisively to his *own* program: in this context, in-depth studies on the transformation of ancient mathematical knowledge in the Renaissance would be a *desideratum*.

The indifferent equilibrium: cornerstone of Guidobaldo's mechanical theory

The indifferent equilibrium for the isostatic balance was an "unheard" novelty presented by Guidobaldo in the *Mechanicorum Liber*, in the context of a vehement discussion about the correct treatment of the balance in Renaissance mechanics. The Marchigian mathematician contested the approaches of mechanical authorities like Jordanus, Tartaglia, Cardano and Benedetti. His theory triggered a large debate in the centres of mechanical studies, meeting mainly scepticism. Guidobaldo tried to overcome this refusal both with the publication of other writings in this regard, as well as with the dispatch of real exemplars of the isostatic balance confirming his theory.
My researches conducted in this context started from previous studies on this subject, by scholars like Montebelli, Bertoloni-Meli or van Dyck, and amplified their scope: the analysis was not limited to the *Mechanicorum Liber*, but extended also to Guidobaldo's other writings, as well as to his correspondence. On

this basis, I have come to the conclusion that the theory of indifferent equilibrium had profound consequences for Guidobaldo's ulterior scientific activity: precisely, for the very foundations of his mechanics. It can be regarded as a crucial element of his whole mechanical theory.

Differently to nowadays, when the topic of the isostatic balance seems to be a somewhat secondary problem of mechanics, it was one of the most vehemently discussed subjects in sixteenth-century mechanics. The scepticism and rejection met by Guidobaldo's theory can presumably be explained by the clash of the fundamentally different mechanical traditions, coexisting in the sixteenth century: in fact, it was the way of their respective, different treatments of the isostatic balance that clearly manifested the incompatibility between these theories. It is in this regard that Guidobaldo harshly criticised Jordanus, emphasising the contrast of his theory with Archimedes's one.
An additional obstacle for the acceptance of Guidobaldo's approach was the fact that isostatic balances were high precision instruments which were not at the disposal of the generality of the scholars of mechanics; in contrast, the context of his work offered to the Marchigian mathematician the possibility to control his theory by direct experience.

Guidobaldo pursued several strategies to justify his theory: first, he explained his treatment on the mathematical level, with ample critiques against his opponents (in the *Mechanicorum Liber*). Then, after having realised to have not convinced his critics, he sent isostatic balances to his interlocutors, even in Spain, despite of the notable efforts it demanded. The persistent rejection of his treatment – think of Benedetti's theory of the isostatic balance, some years later – moreover induced him to insert a scholium in the Italian translation, *Le Mechaniche*, of his principal work. Even years afterwards, it constituted one of the reasons that made him publish his *Paraphrasis*, commenting on the *Equilibrium of Planes* that explained the foundations of Archimedes's mechanics: these were necessary for the comprehension of his own treatment of the isostatic balance.
This fact of defending his own mechanical theory in the *Paraphrasis* implies two relevant consequences for the valuation of Guidobaldo's mechanics: firstly, it gains a thematic coherence which priorly could not be expected: in effect, at *first* glance, the *Mechanicorum Liber*, with its treatment of the Simple Machines, does not seem to have much in common with the *Paraphrasis*' comment on the *Equilibrium of Planes*, dealing with geometric objects not even endowed with gravity. Secondly, it entails a change of perspective in regard both of this specific writing and of Guidobaldo's scientific work in general: surely, he intended also to complete his master Commandino's work of restoring Greek mathematics with the comment on Archimedes's principal mechanical treatise. Yet, for Guidobaldo the defence of his *own* mechanics had a similar role. Therefore his contribution

to the *Archimedean revival* are interwoven with the development and pursuit of his own scientific projects; consequently, his mechanical work is characterised by *innovative* traits in a higher degree than it has been thought.
One of the results of Guidobaldo's propaganda for his "unheard" theory was even the dissociation from his master Commandino: the latter, editing Archimedes's *Quadrature of the Parabola* (1558), had presented a translation of a decisive passage that (consciously or unconsciously) interpreted the conception of equilibrium in Archimedes as stable – in contrast to what Guidobaldo had stressed in the *Mechanicorum Liber* and *Paraphrasis*, because such an interpretation of equilibrium would be equivalent to the "destruction of the concept *centre of gravity*" for the Marchigian mathematician.
The topic had also profound implications for his mechanics from a meta-theoretical standpoint: it became a kind of touchstone of other scholars' theories – who contradicted his solution for the isostatic balance would have necessarily used erroneous principles (granted that the rest of the argumentation was correct).
Finally, it seems to have had significant (negative) consequences for Guidobaldo's Theory of Equilibrium: his special conception of equilibrium as indifferent, comprehensively considered by him as fundamental conceptual achievement, ironically constituted a serious conceptual problem for the establishment of a coherent theory based on the Archimedean basic notions. An approach like Maurolico's, bringing in relation the notions *proto-moment* or *equilibrium* with the horizontal position of the balance beam, was not acceptable for Guidobaldo. On the other hand, the conceptual difficulty the indifferent equilibrium was to be handled with in that context, seem to have provoked a contradiction of respective passages in the *Paraphrasis* and the "Letter to the Goth", regarding the logical dependence between the two concepts of *equilibrium* and *proto-moment*. Without a satisfactory definition of (indifferent) equilibrium – the only kind of equilibrium acceptable to reconstruct Archimedes's Theory of Equilibrium, in Guidobaldo's eyes – he seems to have drawn on the concept *aequeponderare* for its characterisation, which leads to a circular reasoning.

Eventually, it seems advisable to dwell on the following final consideration: one might object that the topic of the isostatic balance and its indifferent equilibrium has not to be considered as really belonging to mechanics, but rather as a a theoretical, mathematical curiosity.
This objection obviously cannot be in accordance with the results of the researches conducted on this subject, for several reasons: firstly, the isostatic balance was a problem that occupied nearly all "major" scholars of mechanics, even such with a rather practical background as Tartaglia. The vivacity and vehemence of the discussions in this regard – Tartaglia was siding with Jordanus ignoring Archimedes's mechanical principles, Cardano criticised Jordanus and referred to Aristotle, Guidobaldo attacked Jordanus, Tartaglia, Cardano and combined

Archimedean and Aristotelian elements in his treatment, Benedetti passed over Guidobaldo and disagreed, on his part, with Tartaglia, Jordanus and Aristotle – testify that it was by far not regarded as a marginal topic or an abstract intellectual amusement. Secondly, it was closely connected with the problem of the very foundations of the respective theories: sixteenth-century mechanics was composed by various diverging traditions, whose partial incompatibility is brought to light exactly by the problem of the isostatic balance. So, the (correct) theory of the indifferent equilibrium was not reconcilable with the *gravitas secundum situm*-theory, with Cardano's *angulus a meta*-magnitude or with Benedetti's approach of the *Diversarum Speculationum Liber*. Thirdly, Guidobaldo's theory of the Simple Machines is based on this kind of equilibrium. In its present form, it would not have been thinkable without it.

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Part D

Appendix I: Documents for a reconstruction of Guidobaldo's biography

All transcriptions of Latin or sixteenth-century Italian texts contained in the present doctoral thesis, both stemming from manuscript material as well as from (antique) printed books, have been effected with recourse to the following

TRANSCRIPTION CRITERIA

The transcriptions generally follow as close as possible the originals, except from the few cases enumerated below. This proceeding intended to conserve the characteristics the originals documents as far as possible. In order to avoid, at the same time, a bad readability of the transcriptions, the orthography has been adapted, in the following few cases, to the modern one, on condition of conserving the phonetic value of the texts.

1. Accents, Apostrophes, Punctuation, Paragraphs, Capital/Small Letters:
   have been systematised on the basis of the modern use.

2. The use of the letter "h":
   has been aligned with the modern use, with exception of words of classical origin, as "Mechaniche", "Mathematiche" or, *e.g*, "hon.do".

3. The use of the letter "j" and combinations "-ij" and "-ii":
   the letter "j" has always been transcribed with "i"; the combination "-ii" has always been conserved, while "-ij" has been rendered as "-ii".

4. Titles of works:
   The citation of writings is indicated with the use of italic typesetting; similarly, also single chapters, if endowed with an own name.

5. Foreign words or dicta:
   are indicated in italics.

6. Numbers:
   have generally been wrote out in full, both cardinal as ordinal numbers. This regards in particular also mixed forms like "9mbre" > "Novembre". Possible bars other numbers (*e.g.* in mathematical texts) have not been reported. An exception is constituted by the day of the month at the end of letters.

7. Compound and separate spelling of words:
   Words written separately have been joined if they constitute one unique word according to the modern use and if this compound spelling would not entail a reduplication of consonants.
   If the compound spelling, in contrast, would lead to a reduplication of consonants according to modern orthography, the words have been rendered in separate spelling.

8. Abbreviations:
   have generally been wrote out in full.
   Exceptions are constituted by the formula for beginning or ending a letter. In this context, in order to avoid any ambiguity, the various abbreviations for "Signore" (Sig.r, S.r etc.) have been unified and rendered as Sig.r, while the ones of "Servitore" have been quoted with "ser.re".

In the following, particular situations, the original orthography has been conserved:

9. The syllables "ti":
   have been rendered unchanged, also its variation "-tti-".

10. Inconsistent forms of names, or variants that do not correspond the today adopted ones:
    have been conserved. In cases that might have been able to provoke confusion, there has been added a note.

11. Single or double consonants:
    have been rendered in the orthography of the original.

Symbolic conventions

12. Page change:
    is indicated with " // " .

13. Illegible words or passages:
    have been signed with asterisks " ** " .

14. Additions and passages of uncertain readings:
    Passages of uncertain readings have been highlighted with square brackets " [.] ". In the case that additions seemed to be necessary for the comprehension of the respective citations, these have been included in hooked brackets " < . > ".

Chapter I

Sources for Guidobaldo's biography

The manuscript BOP, ms 758 of the Biblioteca Oliveriana (cf. Appendix I, II.2) furnishes precious information about Guidobaldo's life. It presents, however, some inexactnesses and, given its limited length, it necessarily cannot present an exhaustive biography of Guidobaldo.
The documents exposed in the present "Appendix I" shall serve to correct imprecisions of BOP, ms 758 (and of other biographical accounts) and to fill some of the lacunae still extant in regard of Guidobaldo's life.

I.1 Guidobaldo's early years

I.1.1 Guidobaldo's childhood

BOP, ms 758 reports that Guidobaldo was born on the 11th of January 1545 at Pesaro, remarkably with the Duke as his godfather. In this time, his father Ranieri dal Monte was often away from home, as one of the most important military captains of Guidobaldo II della Rovere, who, on his part, had to fulfil duties connected with his service towards the Venetian Republic. His mother Minerva Pianosi, in contrast, was member of the Duchess' court which stayed at Pesaro. So Guidobaldo most presumably passed his first years at his home-town.
Then, in 1549, the the court of Vittoria Farnese undertook a journey to Venice to reach the Duke, probably in occasions of the birth of the heir to the throne Francesco Maria.[1]
Also Minerva Pianosi participated in this trip and, with all probability, also Guidobaldo dal Monte; so his brother Francesco Maria, the future Cardinal dal Monte, was born at Venice, on July 5th: in February, they were still at Pesaro,[2]

[1] Francesco Maria, the future Duke Francesco Maria II della Rovere, was born on February 20th 1549.

[2] Cf. the signature of ASF, Ducato di Urbino, Classe I, 109, fol. 242r/v.

then in July at Venice (Francesco Maria dal Monte was born there) until August,[1] as in September they were returned to Urbino.[2]
The following letter testifies that Guidobaldo's mother was part of Vittoria Farnese's court:[3]

> Ill.mo et ecc.mo S.or mio sing.re,
> son già sei dì, o mesi per me, ch' V. Ecc.a partì. Se volessi attenderme la promessa, penserei ch'ormai s'inviasse ma non so ch' me credo. Sto fra la speranza e'l timor, La prego quanto più posso voglia retornar pressto con sanità se va pur fuor', ma cossì cossì.
> Visiti non vi vengan molti. Ier' vi fu m.s Ant.o Cappello e me domandò quando pensavo ch' V.Ecc.a tornasse. Le disse ch'no'l' sapevo, son trissti loro non se li dice no ma se torna da una persona pressto.
> La S.ra Camilla sta con un po' di catarro e un po' di febre da stanotte in qua, ma non serà niente, V. Ecc.a non se ne pigli fasstidio. La S.ra Felice sta ben', la contessa del S.or Ranier <Minerva Pianosi> ier'e stanotte è stata male di doglia d' stomaco, oggi sta assai ben' ma con un po' d' febre, pur secondo Marco non serà niente.
> Cossì spero in Dio, bacio umilmente le mani di V. Ecc.a ch'Idio di mal La guardi e me tenga in gratia di quella. De Venetia alli 3 d'Ag.to nel XLVIIII.
> Di V. Ecc.a
> Umiliss.ma serva e am.ma
> Consorte sempre

From the end of 1549 to the end of 1550 there are no letters between Duchess and Duke. Given the conspicuous number of conserved letters between the two of those years, it is plausible to assume that the cause of the absence of letters is the Duke's sojourn at Pesaro in this period.
Then, at the end of 1550, he seems to have turned to Veneto, together with Ranieri dal Monte.[4]

> (...) Le bacio le mani di quessto comandamento ch' ma fatto fare l'imbasciata alla S.ra sorella, la qual desidera la tornata di V. Ecc.a. Mo dopiamente l'una e l'altra sta ben e bacia le mani di quella cossi fa D. Virginia e sta sana col suo fratellino <Principe Francesco Maria> ch' tutto el dì vol scriver al S.or Pa.<dre> e scrive benissimo com' V. Ecc.a vedrà per una sua al S.or Ranier. La S.ra Camilla sta assai ben', s' fa grossa. Io non manco d' quel ch' so d'acarezarla e avern'

[1] Cf. the signature of ASF, Ducato di Urbino, Classe I, 109, fol. 243r/v and fol. 244r reported in this section.
[2] . the signature of ASF, Ducato di Urbino, Classe I, 109, fol. 252r.
[3] ASF, Ducato di Urbino, Classe I, 109, fol. 244r.
[4] ASF, Ducato di Urbino, Classe I, 109, fol. 286r.

> cura, e'l' fo con tutto el cor (...) di Pesaro alli XVI di Novenbre del Lta.

Also the following document testifies the vicinity of Ranieri's young sons to the court: the Duchess reports to Guidobaldo II that "Ranieri's son continues to have fever, but he stays somewhat better". Waźbiński identifies "el putto del S.or Ranier" with Francesco Maria dal Monte, but we could not find any prove for this claim. So it could also be Guidobaldo who was seriously ill.[1]

> Ill.mo et Ecc.mo S.or mio sing.re,
> el Mastro d' Casa, el Proveditor medico che mandan li dinari per agosto. Qua tutti stanno ben', le S.re sorelle, D. Virginia bacia le mani di V. Ecc.a, el puttino <Francesco Maria della Rovere> sta ancor lui ben', Dio laudato, tutte quest'altre Signore bacian le mani di V. Ecc.a.
> El putto del S.or Ranier seguita pur col pusso e con la febre, ma sta alquanto meglio. E' vero ch' ne moran tanti di questo male che cosa grand' questo m' fa paura, pur spero in Dio e nella bona cura che li fa m.s Marco con questo principio di meglioramento. (...)
> Di Urbino alli III d'agosto del 1551

Then, at the age of about 7 years, that is around the year 1552, Guidobaldo entered in the service of the young Prince Francesco Maria, as BOP, ms 758 reports, "eating always at his table and staying always with him". So, the close relationship that Ranieri had to Guidobaldo II and the young Francesco Maria is reflected by his son's to the Prince.
Again ms 758 tells us that the two attended the same lectures and had the same teachers, until Guidobaldo went to Padua, and the Prince at the Spanish court at Madrid.

I.1.2 Guidobaldo in Padua

Pretty little is known about Guidobaldo's early time, which regards also his early formation and his stay in Padua in the early sixties. BOP, ms 758 reports the following reply to the question about who were Guidobaldo's teachers and about his sojourn at Padua:

> Mentre che egli <Guidobaldo> cresceva in queste discipline cominciò a darsi a gli studii delle Matematiche, per il ché di età di 19 anni andò a Padoa per lo studio della filosofia, ma più vivamente attendeva alle

[1] ASF, Ducato di Urbino, Classe I, 109, fol. 318r/v. Waźbiński cites this letter with the number "116", which corresponds with the numeration of the letters written by Duchess Vittoria Farnese.

> dette Matematiche, et ivi trattenutosi un sol'anno se ne tornò alla corte al medesimo servitio del Signor Prencipe <Francesco Maria della Rovere> come prima.

So this passage would fix Guidobaldo's stay at Padua to the year 1564. Yet, a recently discovered document seems to indicate that Guidobaldo, together with his brother Francesco Maria, went there already towards the end of 1563:[1] In fact, Colonel Agostino Clusone, "Capitano dell'Artigliaria" in Padua, wrote on November 25th 1563 to Duke Guidobaldo II that he was going to satisfy the Duke's wishes regarding "Sir Ranieri's sons" conceding them the license to carry arms. Now, the context makes sure that "Sig.r Raniero" is Guidobaldo's father and that Guidobaldo and his brother Francesco Maria are meant with "his sons".[2] The letter with the Duke's request suggests that Ranieri's sons had already been present in Padua at the time the letter was written, or, at least, that their coming was immediate.

> Ill.mo et ecc.mo Sig.r mio sempre oss.mo,
> l'infinita benignità et cortesia con che V.S. Ill.ma si degna di commandarmi, non desiderand'io altrettanto in questo mondo cosa alcuna che occasione di poterLa servire, mi è infinitamente cara per veder la memoria che la Eccellenza Vostra conserva del Suo antiquo et amorevole servitor: il perché conosciendo dalle Sue amorevolissime lettere l'affettione che porta, et il desiderio che tiene del bene del S.r Raniero mio antiquo et amorevole amico et Signore, per amor di V.S. Ill.ma et del S.r Raniero et Dio insieme, ricevendo io favor infinito et contento a poterLa servir, non mancherò in tutte le occasioni che, et con aiuto et consiglio potrò giovar ai figliuoli del detto Sig.r Raniero, che V.S. Ecc.ma nelle Sue mi raccommanda purché essi mi dimandino et adoperino et così in far lor aver la licenza di poter portar l'arme come in ogn'altra cosa che si rappresenti.
> Et senza più pregando ogni felicità et contento a V.S. Ill.ma nella Sua buona gratia tutto mi dono et raccomando, pregandoLa a servirsi di me et addoperarmi in quelle cose che sono buono a servirLa, che mi farà favor singular et appiacere. Da Padova a XXV di Novembre 1563.
> Di V.S. Ill.ma et ecc.ma
> Affettionatiss.mo ser.re
> Augustin Clusone Capitano del Artigliaria

Thus, this document permits us to identify the beginning of Guidobaldo's Paduan sojourn with the end of 1563, with good probability.[3]

[1] ASF, Ducato di Urbino, I, 217, fol. 335r, autograph.

[2] Ranieri had three sons that survived childhood: Guidobaldo, Francesco Maria and Federico. The latter was born in 1555 and thus seems to young to have already gone to Padua in 1563.

[3] Further, it permits also to date the beginning of the Paduan period of the future Cardinal dal Monte. Until now, it was thought that also Francesco Maria dal Monte went to Padua only

Another problem is the duration of his stay at the Venetian university centre. As we have seen, BOP, ms 758 claims that the Marchigian mathematician stayed there "only one year". However, such a short period can be called in question:[1] firstly, Guidobaldo's had excellent relations to exponents of the Paduan academical world, like G. Pinelli and G. Contarini,[2] which would be hardly explainable after only one year at Padua. Further, it seems improbable that the Marchigian mathematician turned to Pesaro in order to serve the Prince, as claimed by BOP, ms 758: the latter was just about to depart for Spain (in 1565) where he dwelt about three years.
A more probable end of Guidobaldo's Paduan stay might be the year 1566, when he went to war in Hungary under Aurelio Fregoso (cf. the next subsection I.1.3).

Further, apart from dating Guidobaldo's sojourn, we hardly know anything about which lectures Guidobaldo frequented. From the cited passage of BOP, ms 758 we can deduce that among them there were lectures on philosophy, but then also on mathematics. In fact, the only concrete information in this regard is reported by Ireneo Affò who apparently had still access to Guidobaldo's Vita composed by Baldi. So, the eighteenth century scholar wrote in his biography on Baldi (p.9/10):[3]

> In Padova dunque ardendo di desiderio di sapere alla facoltà della Logica <Baldi> si appigliò, in cui non passarono molti mesi, che fece molto profitto, onde s'inoltrò nello studio della filosofia. E perché le mathematiche facoltà sopra tutte le altre all'estremo lo dilettavano, si fece discepolo di Pietro Catena, che in quello *Studio* teneva lezioni sulla *Meccaniche* di Aristotele.
> Del che siamo certificati dal Baldi medesimo, che nella *Vita* impresa a scrivere di Guidobaldo de' Marchesi del Monte, narrato avendo che questi fu dal Catena ivi ammaestrato nel 1564, soggiunge: "quem nos decennio post ex eodem suggestu *Mechanicas Aristotelis Quaestiones* infrequenti sane auditorio explicantem audivimus.

As the present subsections evidences, we are only at the very beginnings of an even approximate cognition of Guidobaldo's stay at Padua. Thus, in-depth studies

later, around 1565, cf. Z. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, 2 voll., Firenze, Olschki, 1994.

[1]This point would not be the only inexactness of BOP, ms 758. Despite of its high grade of reliably, some of the information given by it, is demonstrably inexact; cf. Appendix I, section II.2.

[2]Think of the several letters written by Guidobaldo to both of them; further, Guidobaldo seems to have written a paraphrase on a work of Hygenius at Pinelli's instance, as Muzio Oddi tells: cf. E. Gamba, V. Montebelli, *Le Scienze a Urbino nel tardo Rinascimento*, cit.

[3]Cf. I. Affò, *La Vita di Monsignore Bernardino Baldi*, Parma, Carmignani, 1783.

on this period, surely instructive and influencing for his ulterior scientific work, would be a *desideratum*.

I.1.3 The military campaign in Hungary in 1566

It is again BOP, ms 758 that reports Guidobaldo's participation at the military campaign in Hungary (and so do the sources depending on it),[1] when troops under the Imperial command fought against the Ottomans.
Guidobaldo accompanied Aurelio Fregoso, a rather famous *condottiere* and his father-in-law,[2] who was in the service of the Grand Duke of Tuscany (despite of being subject to the Duke of Urbino). Fregoso commanded 3000 men, other details have not been known about the campaign until now.

We have found the following letters, written by/to Fregoso to/by the Grand Duke of Tuscany, his son and his office, conserved at the National Archive of Florence. They shed some light on the developments of the campaign. In the first one,[3] the *condottiere* reports on the Ottoman movements and sent military drawings of strategic places in his proximity, while garrisoned with his men near by Györ (Hungary):

> Ill.mo et ecc.mo Sig.r, Sig.r e P.ron mio sempre oss.mo
> Per non esser io troppo buon dipintore, et essendo ora nelle facende di là votate con la pala e con la zappa, non ho mandato a V.E.I. il disegno di parte di queste bande, in particolare di quello di Segetto, e poi per averlo mandato al Sig.r Principe quale son certo che S.E.I. ne farà parte a V.E.I.
> E di novo non v'è altro se non che stiamo aspettando il Turco allegramente et con gran cose; quale dippoi la presa di Segetto s'era risoluto volersi riposare venti giorni, sì per riposarsi, com'anco per provedersi. Ma di poi S.M.tà ha auto nova che il Turco aveva dato comisione che tutte le vettovaglie marciasserò pian piano alla volta nostra e che s'era risoluto venirci a ritrovare dove che S.M.tà s'è accampata intorno a Chiaverino. E qui s'è fatto forte con le trincere intorno a tutto il campo. E li soldati di V.E.I. stanno benissimo, e se verrà occasione faranno quanto è animo di V.E.I. e si faranno onore.
> Ne v'essendo altro di nuovo supplico V.E.I. che mi vogli tenere in Sua buona gratia. E che si vogli ricordare che Li sono fedelissimo servitore. E con questo fine con ogni riverentia Li bacio le mani. Del Campo

[1] BOP, ms 758 ascribes to Guidobaldo "about 22 years" when he went to Hungary, practically in agree with the year 1566.

[2] Guidobaldo's sister Virginia (1548-1609) had married, in 1564, Ottaviano Fregoso, Aurelio's son.

[3] Cf. ASF, Mediceo del Principato, 522, fol. 809r.

a Chiaverino il dì 21 di settembre 1566.
Di V.E.I.ma
Fideliss.o et obligato ser.re
Aurelio Fregoso

The same day, Fregoso wrote to the Prince of Tuscany Francesco I as well,[1] as also suggested in the letter above. He apparently attached the cited military map of the proximities which, however, seems not to be conserved any more.

Ill.mo et ecc.mo Sig.r, Sig.r et P.ron mio sempre oss.mo,
ieri che fussimo alli 20 <settembre> ebbi una di V.E.I. alla quale non dirò altro, solo che quella mi cognoscerà ch'io Li sono quel servitore che sempre Li son stato e sempre mi cognoscerà a un modo. Circa del negotio che V.E.I. mi scrive, La sia certa ch'io non mancarò negoziarlo con quella fede et con quella diligentia che mi si conviene, che per gratia di S.M.tà non m'è mai negato il poterli parlare; pure in questo starò aspettando che venghi occasione e di già non manchai ier' sera che mi venne comodo incominciarne a parlare con S.M.tà quale cortesissimamente m'ascoltò e con quella amorevolezza che sempre ho cognosciuta verso S.E.I.
E S.M.tà com'anco S.A. m'hanno comandato che sempre come scrivo a V.E.I. Gli faccia le loro raccomendationi. Il simile m'ha preghato ch'io faccia Mons. D'Arach et il Sig.r Baron di Pernestan, l'amorevolezza de' quali è incredibile; però mi parerebbe bene s'a V.E.I. paresse scriverli una Sua, con ringratiarli di questa loro tanta amorevolezza, verso le genti di V.E.I.
Il Duca di Ferara è qua con la reputazione ch'io scrissi a V.E.I. Ora la professione di S.E. è del magior capitano che sia mai stato o sia, con un rumor d'aver menato tanti ingignieri e capitani ch'è cosa da non credere, et io me ne sto vedendo et preghando Iddio che venghi occasione ch'ancorché come dissi nell'altra mia a V.E.I. siamo mal vestiti, ci porteremo nell'occasioni di tal sorte che potremo stare al paragone delli adobati, d'oro et argento e li soldati stanno benissimi e faranno quanto è il voler di V.E.I.
Scrissi ancora nell'altra mia a V.E.I. di mandarsi il disegno di Segetto qual Gli lo mando ora insieme con un poco d'un altro disegno acciò V.E.I veda un poco.
Di nuovo non v'è altro, solo ch'il Turco doppo la presa di Segetto si risolvette riposarsi vintidoi giorni, de' quali ne sono passati più di quindici e fa fare gran munitione per la via di Strigonia e di Buda, e si dice che vuol venire a ritrovarci. Ancorché potrebbe fare strada più corta, pure per la comodità del fiume del Danubio s'estima che farà la

[1] Cf. ASF, Mediceo del Principato, 522, fol. 810r/v.

più lunga. // S'estima ancora che voglia andare alla volta di Belgrado e di lì poi ritirarsi, pure non si sa del certo quel che lui voglia fare. S.M.tà s'è accampato inanti a Chiaverino con le trincere intorno e si sta aspettando a vedere quel che voglia fare l'inimico. Doppoi scritto è venuto nuova come il Turco ha preso Baboccia, luoco vicino a Segetto, con doi altri lochetti il nome de' quali non scrivo per essere di poco momento. E credo piglerà tutti questi luochi per essere piccoli. Né per ora v'è altro di novo, ma facendo fine con ogni riverentia Li bacio le mani. Del Campo di Chiaverino il dì 21 di settembre 1566
D. V.E. Ill.ma
Fideliss.mo et obligato ser.re
Aurelio Fregoso

A plausible *terminus ante quem* for the end of the Hungarian campaign is February 1567: [1] a letter from the Tuscan grand-ducal office commissions Fregoso to betake himself to the Isle of Elba.[2] Note that the letter bears the date February 18th 1566: this corresponds to February 18th 1567 according to the modern calendar. In fact, the Florentine calendar observed the "style *ab Incarnatione*": the new year began with the 25th of March, with the numeration of the year postponed by one unit regarding the modern calendar (from March 25th to December 31th, it corresponds with it).[3] We will cite the long letter only partly, as the rest contains a detailed description of the military-political situation in the Mediterranean Sea, not relevant for our purposes:

Instruttioni a Voi, Aurelio Fregoso, di quanto dovete fare in Portoferraio, de 18 di febr. 1566;

Condotto che vi sarete in <Porto> Ferraio darete le lettere del Duca nostro Sig.re et nostre al secretario del S.r Alfonso d'Ornano acciò le presenti al suo patrone.
Fateli commodità di fregata o di barca per passare in Corsica, così sempre che se ne vorranno servire per venire o tornare. Date ordine al commissario nostro di Portoferraio che il detto secretario o altri di loro ne sia accommodato.
Voi vi fermerete in Portoferraio dove aspetterete o lettere o mandati. Se saranno lettere inviatecele subito per persona fidata. Se saranno mandati intenderete le loro commessioni, le facultà che portano, chi

[1] This date constitutes a *terminus ante quem* for the end of Guidobaldo's military experience in Hungary obviously only if we suppose that he did not continue to fight under someone else's command.

[2] Cf. ASF, Mediceo del Principato, 5923; fols. 32r-40v.

[3] In fact, still today, in Pisa the 25th of March is celebrated as the "Capodanno Pisano", the Pisan new-years-day. Also Pisa has been observing the "style *ab Incarnatione* in past, yet in advance compared to the modern calendar.

li manda et le qualità di mandati avisandocene minutamente quanto prima, acciò possiamo ordinarVi quel che abbiate da fare più di quello che Vi s'è detto in voce.
In ogni occasione dovete tenerli ben disposti et mostrar loro la voluntà che portiamo a quella natione sendo stata da questa casa conosciuta sempre amorevolissima et devotissima. Non avete a partirVi di <Porto>ferraio senza nostro ordine dando nome d'esser là per visitare quel luogo et provederlo di quel che fusse necessario per li sospetti che si hanno dell'Armata turchesca.//

Il Ser.mo Re Cath.co questa estate non potrebbe valersi de più numero de galere che l'infrascritte:
25 di Spagna
3 di Savoia
2 di Monaco
12 del Sig.or Giov. Andrea
4 della Sig.ria di Genoa, non obligate ad alcuno ma le accomodarebbe
14 di Napoli
16 di Sicilia
4 di Malta
6 del Granduca

Queste sono galere 80 le quali nondimeno per contare più securamente si potrebbono mettere per 75. Ma perché la Spagna ha di fronte l'Africa, et in Algieri vi è sempre qualche numero de vaselli et è credibile che S. M.tà vorrà far passare questa // estate la Regina sua moglie d'Italia in Spagna seguita che la M.tà S. Cath.ca sarà necessitatissima a tener impiegate quest'anno almeno 30 o 35 galere per suo servitio, avendo massimamente acceso in casa il fuoco della guerra de' mori, e restando la goletta dopo la perdita de' tunisi non senza pericolo. (...)

I.2 Guidobaldo's advanced mathematical studies and relevant contemporary happenings in the Duchy

I.2.1 Guidobaldo's advanced studies and their applications

Guidobaldo's occupation with scientific instruments

An insight into an important facet of Guidobaldo's work is offered by the two works of Muzio Oddi *De gli Horologi solari* and *Fabrica et Uso del Compasso*

polimetrico. There, he describes Guidobaldo's interest in the fabrication of scientific instruments and his ability to invent new devices, like a clock by refracted rays and a proportional compass.[1] It was a relevant part of his work, with profound consequences for its theoretical level, as particularly Part B, chapter I shows. Orazio dal Monte confirms the invention of several scientific instruments by Guidobaldo.[2] Traces of the development of other scientific instruments are testified also by some entries in the *Meditatiunculae*.[3]
As we come to know by Oddi's accounts, Guidobaldo must have frequently worked with Simone Barocci, a famous constructor of scientific instruments, particularly in the early seventies: so Oddi tells in *De gli Horologi Solari*:[4]

> Chi di così curiosa cosa <l'orologio a raggi rifratti> ne sia stato l'autore, non saprei darne certa notitia, non sapendo che nessuno degl'antichi n'abbia lasciato memoria alcuna.
> Ben so de' moderni, che l'anno 1572 l'illustrissimo Signor Guidobaldo de' Marchesi del Monte ne fece fare uno da Simone Baroccio, eccellente artefice, in una mezza sfera d'ottone, e hollo avuto nelle mani molto tempo; il quale servì poi come per modello d'uno, che d'ordine del Duca Francesco Maria Secondo ne fu fabricato entro la tazza della fonte, che è nel Giardino pensile del suo magnificentissimo palazzo d'Urbino, come si vede fino al // giorno d'oggi.

The narration exposed in the *Fabrica et Uso del Compasso polimetrico* about Guidobaldo's development of Commandino's compass probably refers to about the same time:[5]

> L'Illustrissimo Signore Guidobaldo de' Marchesi del Monte, che in quei tempi si tratteneva in Urbino per conferire i suoi studii con il Commandino, et spesso era alla casa dove lavorava il <Simone> Baroccio, avendo più volte veduto il sopradetto istrumento <il compasso di Commandino>, et considerando con la felicità del suo ingegno che si poteva sodisfare al medesimo desiderio con assai minor fatica e spesa, ne fece dall'istesso fare uno con le gambe piane a guisa di due regoli più larghi che grossi, et da ciascuna parte fece che si tirassero linee rette dal centro della snodatura alle punte, segnando quelle d'una parte col medesimo modo, che avea tenuto il Commandino in fare le buche; et quelle dell'altra secondo le grandezze dei lati di diverse figure equilatere, et equiangole inscritte nel cerchio, col diametro

[1] For further information on this aspect of Guidobaldo's activity, cf. Part A, IV.1.2 and Appendix I, I.8.2.
[2] Cf. Appendix I, I.7.3.
[3] Cf. Part A, VI.2.3.
[4] M. Oddi, *De gli Horologi Solari*, Venezia, Ginammi, 1638; pp. 99-100.
[5] M. Oddi, *Fabrica et Uso del Compasso polimetrico*, Milano, Fobella, 1633; pp. 3/4 of the *Proemio*.

uguale a tutta la lunghezza dal centro alle punte.
Il che fu piacciuto oltre modo, sì per la simplicità della fabrica et uso suo, come per lo numero maggiore delle divisioni per le linee rette che l'altro non n'era capace; ma particolarmente per potere con l'istessa facilità dividere anco le circonferenze de' cerchi, et trovare le grandezze dei lati dei poligoni descritti in essi, et molte al//tre cose utili che dipendono dallo scompartimento del cerchio, et così con questo si è continovato molto tempo, essendosene fatti un numero grande per l'Italia et fuori.

Also in the successive years, Guidobaldo did not lose neither the contact to Simone Barocci nor the interest for the fabrication and invention of scientific instruments: for example, with a letter to Filippo Pigafetta in 1581 he sent to the latter two compasses constructed by Barocci.[1]

First works on astronomy and on the *Mechanicorum Liber*

Guidobaldo's first extant letter, conserved at BOP, ms 426, fol. 145r, is the first direct testimony of his beginning studies. Therein, the Marchigian mathematician asked his friend Giulio Giordani if he could send him two books on astronomy from Florence Guidobaldo had not been not able to find in Venice:

Molto mag.co come fratello hon.,
V.S. si degni mandar fidatamente le incluse al S.r Marchese, il quale ho grandissimo desiderio di vedere sì come a Voi et al prete; di nuovo non so che me li dire se non che li mantuani tornaranno presto, e di gratia La mi facci favore di veder se La trova questo libro che in Venetia non l'ho trovato, che per essere stampato di là dai monti forse si trovarà in Fiorenza: *Folium populi* et *Horoscopia* Petri Appiani, in foglio, et è stampato Ingolstadii. E se ben sono doi non di meno vanno insieme, che tutti dui insieme sono alti un bon dito, io desidero d'averlo perché ho l'instrumento d'ottone.
Del resto fate conto che il conte Gio. Battista et io siamo patroni di Pesaro, perché non ci è né duca, né principe, né principesse, né duchesse, né quasi nissun altro. E' ben vero che ci è la principessa d'Urbino che è come se la non ci fusse che La sta un poco male. E così bascio le mani. Di Pesaro alli 16 dicembre 1573.

[1] On April 24th 1581 Guidobaldo writes to Pigafetta (BAM, D34 inf., fol. 113r/v): "Li compassi ancora V.S. gl'averà, ma mi voglio scusare perché quel mastro che è in Urbino, è lunghissimo per li molti lavori che ha da fare. Ma io non mancarò di sollecitar che V.S. gl'abbi quanto prima." Then, on May 2nd, he finally sends two compasses and an isostatic balance (BAM, D 34 inf., fol. 139r): "Mand'a V.S. li compassi et la bilancia. Li compassi Glene mando due para, perché uno serve per far li circoli, l'altro poi per misurar, et hanno le punte di acciaro. Credo che piaceranno a V.S. perché invero il mastro è eccellente. (...)"

Di V.S.
Come fratello e servitore, Guidobaldo
dei Marchesi dal Monte.

We have further found the following documents which probably date from the same period: they testify Guidobaldo's works on a first version of the *Mechanicorum Liber*, and are, thus, extremely precious. In fact, a letter-book of Francesco Barozzi[1] has survived,[2] which comprises, besides two letters between Barocci and Guidobaldo, four folios (fols. 116-119) connected with the latter's work: folio 118 shows, on the left edge of its *verso*, the comment:

> Correttioni del Commandino nel libro del S.r Guid'Ubaldo dal Monte.

It possibly constituted the front side of a folder that contained the aforesaid "corrections", while the folium itself is empty apart from this title.
Then, in effect, folio 117 reports on its *recto* several suggestions and corrections in a clear teacher-to-disciple-style (about a bad linguistic style, about argumentation steps that have to be emphasised, etc.):[3]

> In prima propositione
> *Sitque circa centrum i trochlea, sive orbiculus*: i greci radevolte hanno usato nelle figure la lettera i, et però sarei di parere che si lasciasse, benché ciò importi poco o nulla.
> *Dico quod vis, quae movet* a *in* b *est aequalis*[4] *ei, quae movet* d *in* k: direi più presto "quae movet d in f", benché questo modo di parlare non sia molto latino, perché meglio si diria "dico vim, quae movet a in b aequalem esse ei, quae movet d in f."
> *Erit ergo tanta vis in* b, *quantum est pondus* a: la forza uguale al peso lo sostentaria solamente, ma per alzarlo bisogna, che sia maggiore del peso. Et questo bisogna avertire in tutto il progresso della dimostratione.
> *Pondus in* k *aequeponderabit cum pondere* d *ex prima primi <Libri de Aequeponderantibus> Archimedis*: questa è prima suppositione d'Archimede, non prima propositione. Io più presto direi "aequeponderabit ponderi a".
> *Et propter hoc nec paralelles esse inter se se, nec horizonti perpendiculares.* Non segue per questo, che non siano perpendiculari all'orizonte, percioché essendo la terza spherica, le linee, che vanno al centro sono perpendiculari sopra la superficie, ma pigliando l'orizonte come un

[1] Francesco Barozzi (1537-1604), Venetian mathematician.
[2] The precise collocation is BNP, Ms Latin 7218.
[3] The parts we report in cursive font indicate the passages cited by the teacher, while the other parts in normal font constitute his comments and suggestions that refer to those passages.
[4] aequalis *correxi ex* aeqlis

piano, ciò sarà vero.
Est alia dubitatio: Questo, che V.S. fa per dubitatione, io lo chiarirei per una diffinitione nel principio, o più presto dichiaratione nel modo che si debba intender questo.
In propositione secunda in primo corollario "ita dicendum ex hoc patet ut *ab* ad *be* ita esse pondus *e* ad vim, quae".

Aliter
Iisdem constructis: Questa mat<eri>a mi pare un'altra dimostratione, ma la medesima ch'è di sopra et perciò lasciarei stare.

L'altre cose mi paiono seguitar bene. Ma V.S. avertisca bene all'invention, che la lettera s'accommoderà poi quando sarà l'un risoluta.

The *recto* of folio 116 reports an addition to Proposition I (and the immediately following corollary) in chapter *De Axe in Peritrochio* (fols. 107-109) of the *Mechanicorum Liber* – the quantitative proportion between a weight and a force applied to a winch, where Guidobaldo had confined himself to a qualitative affirmation, with the respective figure (cf. figure I.1), which reappears, almost identically, also on folio 119.

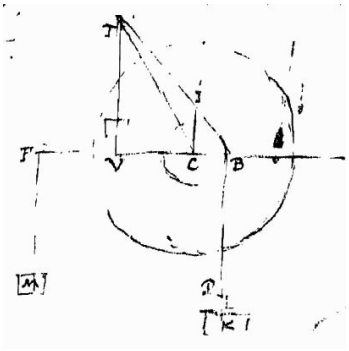

Figure I.1: The figure in ms Latin 7218 on folium 116r.

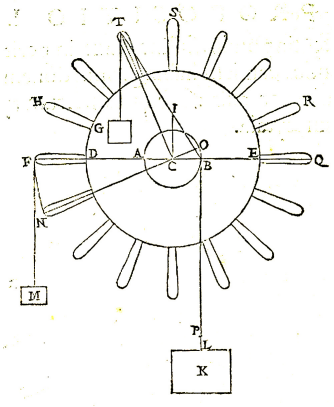

Figure I.2: The figure reported in the *Mechanicorum Liber* on folium 107v.

Pag. 128 fac 2a5
Manifestum est conclusionem esse veram, quod gravius debeat esse pondus in T quam pondus in F, ut sustinere possit pondus in B. Tamen quae propostio sit inter pondus in F sustinens pondus in B, et T pariter sustinens idem pondus in B quaerere debemus[1]. Quod

[1]quaerere debemus *in interl.* *del.* Guidus Ubaldus non ostendit

nullo negotio stante, eiusdem figurae declinatione, meo quidem iudicio, provari potest[1].
Producatur a puncto T linea TV ad lineam FB, quae sit equidistans lineae IC[2]. Et quoniam[3] in triangulo BTV linea TV est aequidistans[4] lineae IC, erit per 2a 6ti BI ad IT, ut BC ad CV. Cum autem demonstratum sit pondus in T ad pondus in B esse ut BI ad IT, eadem ratione demonstrabitur pondus in V ad pondus in B esse ut BC ad CV hoc est ut BI ad IT[5]. Quare idem pondus tam in T, quam in V sustinebit pondus in B.
At pondus in F ad pondus in B est ut BC ad CF, pondus vero in T ad idem[6] pondus in B est ut[7] BI ad IT, hoc est ut BC ad CV. Quare proportio inter pondus F sustinens B, ad T sustinens idem pondus B, est ut inter BF ad BV[8]

Hinc[9] manifestum est Corollarium.

Unfortunately, we do not know anything more precise about this story. In particular, the three folios 116, 117 and 118 seem to be written by three different copyists.[10] Thus, a plausible scenario is this:
Folium 117 is possibly the copy of Commandino's correction on a Guidobaldo's early draft of the *Mechanicorum Liber*, and folium 118 the envelope where folium 117, probably with still other not extant folios with corrections. Folium 116, in contrast, does not seem to belong to Commandino's corrections: there, Guidobaldo is referred to in the third person, while on folium 117 he is directly addressed to with "V.S.", i.e. "Your Lordship". This indicates that folium 119 was not sent to him (whereas folium 117 seems to have been). It could have been a note of Barozzi on the *Mechanicorum Liber*.[11]
A plausible solution of the riddle, how these different folios finished in Barozzi's

[1] provari potest *in interl.* *del.* fieri potest

[2] *post* IC *del.* supponendo tamen inlinationem ponderis in T fieri per lineam TV, perpendicularem ad lineam TB, nulla habita consideratione inclinationis ponderis fieri per lineam versus centrum mundi: tunc enim angulus TVB esset obtusus, sed cum sit insensibilis considerationis habeatur pro recto.

[3] quoniam *in interl.* *del.* cum

[4] est aequidistans *in interl.* *del.* supponitur parallela

[5] hoc $\sim IT$ *in interl.*

[6] idem *in interl.*

[7] ut *bis*

[8] inter $\sim BV$ *in interl.* *del.* inter BC ad CF, ad BC ad CV.

[9] *ante* hinc *del.* Ponitur autem propositio BC ad CF ut quinque ad unum, proportio vero BC ad CV, ut duo ad unum. Sequitur inter F et V, hoc est inter F et T, esse proportionem ut inter tres et sex, quod est unum ad duo.

[10] This is a personal communication by Paolo D'Alessandro and Paolo Cherubini, to whom we want to thank once more in this occasion.

[11] Barozzi knew the *Mechanicorum Liber*, as it was Guidobaldo himself who sent him a copy, cf. the letter of June 29th 1580 (BNP, Ms Latin 7218, fols. 18r-19r).

letter-book, could be the following: we know that, when Commandino's heirs sent his drafts to Francesco Barozzi in 1586 for the translation of Pappus' *Collectiones Mathematicae*,[1] the latter had made all Commandino's documents copy in the shortest time by different copyists. Among these folios, probably put together unsystematicly after Commandino's death and thus presumably without a coherent arrangement, there could have been also some Commandino's papers which had no bearing on the works on the *Collectiones Mathematicae*, but, in contrast, on his corrections of Guidobaldo's draft of the *Mechanicorum Liber*.

I.2.2 Remarkable events in the Duchy of Urbino from 1571 until 1574

The marriage between Prince Francesco Maria and Lucrezia d'Este in 1571

On the 2nd of January 1571 Prince Francesco Maria married Lucrezia d'Este, sister of the Duke of Ferrara, then on January 8th the bride was welcomed at Pesaro.[2] The following account gives an idea about the festivities taken place in this occasion.[3] It moreover permits to distinguish the various "courts" at Pesaro/Urbino: one around of Duchess Vittoria Farnese composed by the noble dames of the Duchy (among them Guidobaldo's mother), and the one around Prince Francesco Maria della Rovere to which belonged also Guidobaldo, as we can see.

> "Nozze e venuta della Sig.ra Donna Lucrezia da Este Serenissima Principessa e Moglie di Francesco Maria II Duca d'Urbino Pesaro 1570"
>
> Partì di qui di Pesaro l'ultimo dì dell'anno 1570 l'Ill.mo Sig. Prencipe di Bisignano con molte poste di gentiluomini che menava seco per andar a levar da Ferrara l'Ill.ma ed Ecc.ma Sig.ra Principessa d'Urbino. Ma non arrivò a tempo, perché S. Ecc.a <Lucrezia d'Este> si mosse il dì seguente, e se ne venne a luogo, accompagnata dall'Ill.mo e Rev.mo Cardinal da Este, e dall'Ill.mo et Ecc.mo Sig.r Duca suo fratello, dove arrivò poi il sudetto Sig. Principe di Bisignano. Il quale accompagnò sempre S. Ecc.a Ill.ma per istrada, fintantoché si giunse a Gradara, luogo di Pesaro.

[1] On this argument, see L. Passalacqua, *Le "Collezioni" di Pappo: polemiche editoriali e circolazione di manoscritti nella corrispondenza di Francesco Barozzi con il Duca di Urbino*, in "Bollettino di Storia delle Scienze Matematiche", XIV 1 (1994). A summary of its content and other information is given in Appendix I, I.4.1.

[2] Cf. J. Dennistoun, *The Dukes of Urbino*, cit., vol. III, pp. 128ff.

[3] Cf. BOP, ms 377, fols. 211r-212v

> Il dì seguente dopo la partita del Sig.r Prencipe si mossero da Pesaro di ordine del Sig.r Duca mo per andar a Ravenna, a ricever S. Ecc.a la Sig.ra Clara Farnese, moglie del Sig.r Gio. Giorgio Cesarino, la Sig.ra Ippolita della Mirandola, la Sig.ra Ippolita Bonarelli moglie del Conte Pietro Bonarelli, la Sig.ra Costanza della Rovere moglie del Conte Fabio Landriani, la Contessa di Montebaroccio <Minerva Pianosi> moglie del S.r Ranieri delli Marchesi del Monte con le sue due figliole, la Contessa di Pian di Meleto, e la Contessa di S. Agata, e la Contessa di Ripa, e Tomba moglie del Conte muto Landriani, in compagnia della quale vi andò oltra infiniti gentiluomini il Rev.mo Monsig.r Arcivescovo di Torino, le quali tutt'insieme con l'Ill.mo et Rev.mo Cardinal di Urbino ch'a questo effetto era partito di qui molti dì prima per trovarsi a ricever nel suo arcivescovato di Ravenna. (...)
> Il sabbato seguente partì di qui l'Ill.mo Sig.r Principe d'Urbino col Prencipe di Massa <Alberico[1] Cybo>, il Sig.r Ippolito della Rovere suoi [consubrini], il Sig.r Guido Baldo de' Marchesi del Monte, il Sig.r Perantonio Lunani suoi cognati di sorelle naturali et il Sig.r Ottaviano Fregoso per andar a incontrar S. Ecc.a, la qual trovarono fuori d'Arimino dov'alloggiarono.
> Quella sera, e dopo l'esser stati il Sig.r Prencipe quella notte con S. Ecc.a se ne tornò indietro la mattina a bonissim'ora con li sudetti, lasciando che dopo lui si partisse nel medesimo giorno S. Ecc.a per venir a Gradara, Castello della Sig.ra Duchessa Ill.ma di Urbino, lontano da Pesaro sette miglia, nel qual luogo era stata fatta provisione per alloggiar S. Ecc.a qualche dì, finché 'l tempo s'acconciasse.

The Urbinate revolt in 1572/73

Another notable event in the Duchy of that time was the revolt taken place in Urbino in the winter of 1572/73. As we will see in the citation after the following, again a member of the dal Monte family, Ranieri, had an outstanding role in the mediations. But first, let us have a glance of a summary of the happenings given by Dennistoun:[2]

> In August 1572, the Duke intimated to the council of Urbino that he had received authority from Gregory XIII to impose a tax of one quatrino per lb. on buchers' meat, and of two bolognini upon every *staro* of grain and *soma* of wine; and in October he made proclamation

[1] In reality, it is not completely clear, if "Prince of Massa" refers to Alberico I Cybo-Malaspina (husband of Elisabetta della Rovere, an aunt of Francesco Maria II), or to his son Alderano who were a talented disciple of Commandino and therefore a fellow student of the bridegroom. The title "Prencipe", however, suggests that the actual participant was Alberico.

[2] J. Dennistoun, *The Dukes of Urbino*, cit., vol. III, pp. 106-109.

throughout the Duchy of these new imposts. It being rumoured that the envoys of Gubbio had obtained for that community a suspension of the obnoxious duties, discontent began to prevail, and on the 26th of December one Zibetto, a cobbler, in an inflammatory harangue, at a public assembly dignified with the name of general council, declared that these were exactions under which the poor could not exist. On his proposal, forty delegates were chosen from the nobility, and sworn to represent the matter to the Duke in person. They repaired to Pesaro, and, on the 29th, had an audience to present the memorial agreed to by the council, which Guidobaldo received, and desired them to go home, promising that an answer would be transmitted when he had considered their statement. They, however, stayed a week, vainly looking for his reply, during which the council met daily at Urbino, and at length they were recalled by an express from the Gonfaloniere.

(...) finding that troops were being secretly organised to garrison their city, the people of Urbino rushed to arms, closed the gates, and, haven mustered above a thousand men, began to strengthen the defences and lay in storcs. (...) The impossibility of doing so against the Duke's military levies being however quickly apparent even to the insurgents, an embassy of six was despatched to Rome to beseech the Pope's mediation. (...) The envoys could get no other reply from his Holiness but that they must go home and make submission and they were followed by a brief from him, enjoining them to lay down arms and seek his Excellency's unconditional pardon. (...)

Notwithstanding this surrender, Guidobaldo advanced upon the city, quartering his troops in the surrounding villages, so as to blockade it, and all the public functionaries were superseded. Dreading a sack, the citizens rushed to the monasteries with their valuables, and, about the middle of February, sent fifty of the nobles to crave pardon of their sovereign. After waiting at Pesaro fro three days, these were admitted to tender submission on their knees, and were then placed under arrest at their inn for twenty days, notwithstanding incessant petitions from their fellow citizens for their release. (...) The property of the prisoners and exiles was confiscated; the city was disarmed; public assemblies were prohibited; and the magistracy were discharged from their duties.

The eyewitness and historian Girolamo Ardizi gives us a contemporary account of the happenings, giving details on some of the elements that Dennistoun reports:[1]

(...) Perciò risolse <il consiglio di 45 nobili pesaresi> di far sapere al Sig.r Duca mediante il sopradetto Sig.r Ranieri dal Monte che

[1]Cf. BOP, ms 377, fols. 241r-245v.

unitamente avrebbono voluto andare ad essibirgli in nome pubblico l'avere e le persone loro come obedienti ch'erano stati sempre a loro Ss.ri, e che ciò averebbono voluto fare prima che arivassero la sera gl'Urbinati. Rifferì il Sig.r Ranieri ch'il Duca si era tutto sollevato a questo avviso e che desiderava che si sospendesse questa azione sino alla mattina seguente per farla sugl'occhi alli Urbinati (...).
Gli ambasciadori d'Urbino per quanto fu detto ebbero a male questa azione che ridondava a loro danno e disonore, tutto che da Pesaresi fusse fatta ad altro fine, che fu il loro particolare interesse, e non ebbero applauso dal mondo tutto. (...)
In questo mezzo si preparavano armi e monizioni da guerra in Pesaro facendo venir genti del suo Stato pacifico, et oltre il grano che aveva in Sinigaglia, mille stara ne concedì lo stesso Sig.re di Forlì. Il Sig.r Duca Alfonso da Este, cognato del medismo Prencipe fu da lui elletto Generale in questa impresa, il Conte Giulio da Tiene Maestro di Campo, Mr. Camillo Giordani da Pesaro Uditore del campo, il Cap. Agostino Monaldi da Pesaro e Mr. Francesco Orlandi Pagatori e Mr. Gironimo Ardizio Commissario generale.
Molti gentilomini d'Urbino affezionati, parte suoi cortigiani e parte venuti in Pesaro per fuggire i pericoli della Patria, pregarono la Signora Duchessa a compiacersi di andarvi, che speravano con la sua presenza si fossero quietati li rumori. Fu lungamente sopra ciò discorso, e conlcuso contro la volontà del Duca, il quale disse alla Duchessa che facesso quello le pareva, ma che s'ella andava, coloro non l'averebbono lasciata tornare e ch'egli non restarebbe di spianare quella città come aveva risolto.
Andò la Sig.a Duchessa accompagnata dal Sig.r Raniero de' Marchesi del Monte, da Monsig.r Giulio Simonetta milanese Vescovo di Pesaro, da Fra Jacomo Sant'Angelo del ordine de' predicatori, teologi di molto valore, dal Sig.r Giovanni Simonetta Segretario già di questi SS.ri molto intendente di materie di stato, et altri gentilomini. Ma indarno perché dopo molte consulte, et aver quasi accordato con la speranza che davano loro gli loro ambasciatori appresso il Papa in Roma, non vollero più rimettersi alla benignità di S.E. (...)
Sì che la Sig.ra Duchessa tornò d'Urbino senza conclusione veruna e mentre il Duca stava in punto di far marchiare il cannone a quella volta, giunse in quella città un breve del Papa che ordinava loro che sotto pena di rebellione dovessero depor l'armi e mandare a chiedere perdono al suo Sig.r.

The courtly Carnival 1574

We have notice about another interesting event in the Duchy, fortunately trans-

mitted by a letter of Tiberio Almerici to his cousin Virginio:[1] the Carnival 1574 at the court.[2] At first sight, the relevance of this fact for Guidobaldo's biography might not seem obvious; yet it is, in reality, a precious document that gives us an idea about the intellectual climate, the interests and the discussions taken place at the court of Urbino at that time – even if the festivities might have been more grandiose than usual in connection with the recent revolt, as Firpo sustains.[3]

> Molto mag.co et hon. cugino,
> ho pensato un gran pezzo per trovar qualche scusa d'un mio sì lungo silenzio con Voi, e s'ho da dirmi il vero, non ho trovato cosa che ritiene, sì che finalmente mi sono risoluto di confessare alla libera la mia trascoraggine, non tanto perché si dica *peccato confessato più agevolemente meritar perdono*, quando perché ogni [scusa] che per caso mi venisse da Voi data, conosco in Voi quasi che di ribalzo poter cadere. E però poiché i falli son pari, vaglia a perdonarcegli l'un l'altro. Io faccio a Voi l'assolutione di tutto il passato et aspetto parimente d'ottenerla da voi, e per l'avvenire siamo alquanto più officiosi l'un l'altro (parlo con queste dimostrationi estrinseche che dell'animo non mi cade dubbio) di quello che siamo stati per lo presente. Io avrei molte cose da dirVi, ma mi riffringerò per ora alle nove di questo Carnevale solamente, perché non ho tempo d'allungarmi molto, e quel ch'ho da dirVi non è poco.
> Questo Carnevale s'è passato più allegramente che non si credeva, e s'è ricompensato in parte quel tempo che si passò con tanto disgusto di questi popoli quest'anno addietro, perché si son fatte molte feste e si sono veduti tre spettacoli publici che furono una Sbarra, una Comedia et una Egloga delle quali tre non m'è parso di darVi conto minutamente, ma con brevità se è possibile.
> La Sbarra fu intimata per un cartello questo mese passato, la copia del quale credo abbiate avuto da Vostro Padre che dice d'avervela mandata, io non mi estenderò a dirVi la querela che già dovete avere intesa essere sopra la lealtà degli amori de' mantenitori, i quali furono il Conte Fabio detto il Cavaglier della Luce e m.s Giovanni Tomasi detto il Cavaglier della Selva Amorosa. Dirò solamente ch il dì innanzi il giovedì grasso fu attaccato un altro cartello di due cavaglieri di Arimino ch'accettavano la battaglia per lo dì seguente e furono il Cap. Mutio Zungolo detto il Cavaglier Costante, et il Cavaglier Ricciardello

[1] Cf. BOP, ms 390, fols. 92r-97v; autograph letter, written on February 28th 1574.

[2] Gamba&Montebelli report a passage of this letter in E. Gamba, V. Montebelli, *Le Scienze a Urbino nel tardo Rinascimento*, Urbino, QuattroVenti, 1988, p. 31.

[3] Cf. L. Firpo, *Lo Stato ideale della Controriforma*, cit., p. 110: "Ai primi del 1574, nel tentativo di rompere quell'atmosfera di risentite paure, la Corte indisse a Pesaro splendide feste carnevalesche; per l'ultima volta la città brillò, galante e spensierata, di giostre, trattenimenti, recite fastose."

detto il Cavaglier della Prima Morosa, la copia del quale cartello non ho potuto avere, né so se Vostro Padre Ve l'abbia mandata. //
Il giovedì a sera poi fu bellissimo vedere nel Cortile grande della Corte, loco attissimo a questi spettaculi, la frequenza del populo, la bellezza delle dame alle finestre e nei palchi, il passeggiare de' gioveni nobili e ben vestiti nello steccato poiché la nobiltà de' gioveni e d'altri gentiluomini era dispensata in mille officii ch'appartengono a tal sorte di Cavalleria. A un ora di notte poi che furono accesi i lumi in quantità grande che taglievano ogn'oscurità alla notte, entrò la guardia fra i due steccati che fu tutta di gioveni della terra com'è il solito. Poi comparsero i mantenitori con bellissima livrea bianca e rossa in questo modo:
Passavano innanzi quattro tamburi vestiti d'ornisino della medesimo divisa con capelli e penacchi.Poi seguivano sei paggi vestiti nel medesimo modo. Poi due nani che portavano due scudi, pure vestiti al medesimo modo. Poi seguivano sei padrini gentiluomini della terra, molto bene in ordine com'erano tutti gli altri che facevano offitio di padrini con gli altri cavaglieri. Dietro loro venivano con bella gravità i due campioni con le loro picche in spalla, con l'armi accompagnate dalla loro divisa, con bellissime pentre e calze superbissime, et ultimamente venivano sei altri paggi vestiti nella medesima maniera con le loro torcie in mano com'i primi che mi s'era scordato di scrivere, e con questa mostra volteggiavano tutto lo steccato fra le due sbarre, e come erano innanzi ai Prenicipi facevano con bella attitudine le loro riverenze, e finalmente si posarono alla loro tenda et padiglione ch'era da una parte dello steccato. (...)

[f.94 centro] Il terzo spettacolo che s'è goduto questo Carnevale è stato d'un Egloga del Tasso che fu recitata questo giovedì prima di quaresima passato, da alcuni giovini d'Urbino nella Sala che fu fatta per la venuta della Principessa et è stata tenuta per una delle vaghe compositioni che siano finora uscite in scena in tal genere perché ci erano bellissimi e piacevolissimi concetti et d'attione ancora che semplice e molto piacevole et affettuosa. E' ben vero che per la verità non è stata in alcune partie principali così ben rappresentata come meritava, massime negli affetti da' quali nasceva il principale difetto dell'Egloga.

(...) Questo è quanto s'è goduto di buono e di bello questo Carnevale a Pesaro. Et inoltre in questo tempo medesimo dell'ultimo del Carnevale abbiamo goduto ancora molti ragionamenti parte uditi con le nostre orecchie e parte riferite da altri che sono passati fra molti begli intelletti come dire il Mazzone da Cesena che credo conosciate per fama e forse anco per vista, il Tasso, il Pino da Cagli e m.s Cesare Benedetti, che non mi sarà grave di riferire in sommario poiché mi

sento di vena per questa volta che valerà per tante altre c'ho lasciato di scriverne.
Intesi primieramente che presò ragionamento innanzi il Principe alla venuta del Mazzone che è stato chiamato a vedere questi spettacoli dall'Abbate <Francesco Maria dal Monte> del S.r Rainero, e fu fra il Mazzone e ms. Cesare sopra la differenza ch'è fra Platone et Aristotile intorno alla Reminicenza, dove il Mazzone cercò di diffendere l'opinione di Platone e de' seguaci, e m.s Cesare vi sosteneva quella d'Aristotile.
Et in un'altra occasione pure nata per incidenti innanzi il Prencipe se l'Odio era contrario dell'Amore, ove medesimamente il Mazzone tenne non esser l'Odio contrario all'Amore e ms. Cesare tenne che sì.
Fra il Tasso et il Mazzone nacque similmente ragionamento intorno alla Poesia, e particolarmente intorno alla forma del Poema Heroico, dove si disse assai intorno all'unità della favola, et altre cose connesse e congiunte a tal materia.
Et un'altra volta innanzi S.Ecc.za discorsero assai sopra l'Attione della Comedia rappresentata dove che il Tasso mostrò d'essere d'opinione che l'attione di questa comedia non fosse convenevole a Poema Comico, ma piuttosto Tragico overamente Epico, essendo che ** che attione così eroica com'è il posporre il proprio volere e diletto per vero zelo d'amicitia sin troppo illustre è però poco conveniente a Comedia.
Un altro ragionamento intesi medesimamente che passò fra il Pino da una parte et il Tasso et il Mazzone dall'altra, dove il Pino si sforzò di provare che Virgilio non avea asseguito il fine del Poema Heroico e però che il suo Poema non era heroico. Ma fu gagliardamente diffeso Virgilio dal Tasso e poi dal Mazzone, come riferiscono quegli che vi furono presenti a tal ragionamento che fu innanzi il Duca e la Principessa.
Un'altra volta s'attaccarono in festa mentre si ballava il Tasso et il Mazzone, et io mi trovai presente. Fra gli altri a una parte della contesa ch'era allora cioè che il Tasso teneva ch'Epicuro ponesse tutto il sommo bene ne' piaceri del corpo e che fosse cattivo, et il Mazzone pareva che tenesse ch'egli avesse avuto sempre buona opinione nelle cose morali e che però egli non fosse tale quale si trova descritto da Cicerone e da Plutarco e parea che si fondasse se ben mi ricordo in una epistola che si trova delle sue e nella sua vita che fa Laertio Diogene, sopracché contesero un pezzo dov'io conobbi veramente che quel Mazzone era d'una gran lettione e di grandissima memoria e dottrina più che mediocre, et il Tasso avvertito molto et accorto ragionatore.
(...)
Di Pesaro l'ultimo di febraro 1574
Vostro amor.le cugino e ser.re

Tiberio Almerici

Even if Guidobaldo is not named explicitly, the following letter testifies that he was in company of Mazzoni, Benedetti, Tasso, together with his brother Francesco Maria dal Monte and others. In fact, Almerico writes to his son Virginio one day after Tiberio:[1]

> Molto caro et amato figliolo,
> (...) Io ti arei desiderato di qua et ms. Tiberio medesimo, fra questi belli ingegni che spesso si trovano insieme circulando: il Mazzone, il Benedetti, il Tasso con questi altri gentiluomini, dottori novelli nostri soliti, et l'abbate <Francesco Maria dal Monte> insieme a quali s'accostano poi diversi gentilomini di spada e cappa, come il S.or Guidobaldo, il Cavaller <Girolamo> Arduino et altri. Ma m.s Tiberio nostro se ne piglia di longhe pasciute con il Tasso. (...)
> Et vivi sano; che Dio sia sempre teco. Di Pesaro il primo marzo del LXXIIII. (...)
> Almerigo Almerici Padre

The death of Guidobaldo II and the ascension to the throne of Francesco Maria II in 1574

An obviously crucial event for the history of the Duchy is constituted by Francesco Maria della Rovere's ascension to the throne in 1574, after the death of his father on September 28th. Again, a letter written by Almerico Almerici to his son Virginio sheds light on the coronation ceremonies:[2]

> Molto caro figliolo,
> (...) Alle 21 ore mandò il S.or Duca lo Ill.re S.or Ranieri et il Conte Fabio <Landriani> a levare il magistrato et accompagnarlo alla corte il quale s'inviò in questo modo: camminavano li 100 putti avanti a 3 per fila et dopo questi seguitavano li 60 gioveni nobili (...).
> Era questo belissimo spetacolo con tanto concorso di popolo che più non si sarrebbe potuto immaginare et era tale che la coda si trovava ancora alla piazzetta quanto il capo, ch'erano li putti dopo l'avver girato tutta la città appena arrivavano alla piazza. Et intrati in corte li putti si fermerno tutti sopra le scale di fuori nel cortile in loco eminente acciò dal S.r Duca fossero veduti et li gioveni s'inviorno di sopra nella sala grande ducale.
> Gionto S. Ecc.a et con gran difficoltà arrivata alle scale fo dato il

[1] Cf. BOP, ms 1577, letter number 23 (there is no folio-numeration in BOP, ms 1577); Almerico Almerici to his son Virginio; March 1st 1574.

[2] Cf. BOP, ms 390, fols. 98v-104r.

> posesso del suo cavallo al Signor Francesco Maria <(II) dal Monte> figliol del Signor Guidobaldo, non avvendo il S.r Guidobaldo voluto accettare la elletione fatta da la nobiltà della gioventù dicendo che in quella occasione era necessario esser sempr'appresso la persona di S.Ecc.a; come si vedde veramente, poiché il S.r Duca lo favoriva di burlar seco molte volte caminando a questa cerimonia con molte [deleezze]. (...)
> Questi appresentati al tribunale in ordine cominzò un cancelliero ducale a stipulare per vigore del mandato questo contratto di fedeltà et d'omaggio nella forma solita a prestarsi et forno li testimonii lo Ill.re S.r Ranieri et il medesimo Conte Fabio (...).

Thus, we see the dal Monte family again in the first line of the court: Ranieri, as well as Guidobaldo and Francesco Maria (II). One of the new Duke's first actions was the divestiture of many of his father's favourites. Firpo writes in this regard:[1]

> Intanto Francesco Maria II veniva maturando tenaci propositi di vendetta a carico di quei favoriti e consiglieri intimi di suo padre che avevano per anni alimentato in segreto le divergenze di carattere e d'opinioni tra Guidubaldo e il figliuolo, allontanando quest'ultimo da ogni affare pubblico, mostrando di tenerlo in dispregio, insidiando fors'anco la sua vita. Di costoro il più autorevole, Pietro Bonarelli, aveva saputo trovar scampo tempestivamente fuggendo in esilio, ma Antonio Stati, catturato e processato per molti abusi e delitti, il primo febbraio 1581 venne decapitato con alcuni complici nella rocca di Pesaro. (...)

We have also a contemporary's account of the new Duke's politics of "personnel restructuring". Almerico Almerici wrote on October 4th 1574 to his son Virginio:[2]

> Questi poveri camareri stanno sospesi: de' servidori del padre sinora appresso a la persona de Sua Eccellenza è stato confimato Guidobaldo <Raffaelli> per salvarobba secreto ma non camerero; e ha preso Vicenzo <Citaredo> musico.
> Il Signor Guidobaldo <dal Monte> è fatto capitano della Guardia de' Lanzi, la quale Sua Eccellenza vole in ogni modo ritenere appresso sé. Levò subbito dal suo offizio il Tenaglia, con sodisfazione quasi universale, ha rimosso medemamente de Urbino messer Antonio Steffani;

[1] L. Firpo, *Lo Stato ideale*, cit., p. 139.

[2] Cf. BOP, ms 1577, letter number 55 (there is no folio-numeration in BOP, ms 1577); Almerico Almerici to his son Virginio; October 4th 1574. Parts of this letter are also cited in G. Montinaro, *Fra Urbino e Firenze. Politica e diplomazia nel tramonto dei della Rovere (1574-1631)*, Firenze, Olschki, 2009, p. 42.

> al Salarino si dice cha ha levato il sigillo e altre scritture importanti. Insomma de servidori del padre intimi non si vede nissuno negoziare oltre che il Signor Veterani secretario e con molta sodisfazione a tutti.

So, Guidobaldo replaced his father as Captain of the "Broken Lances". As the letter emphasises, the new Duke wanted to have this lifeguard close by, which permits us to deduce, in particular, Guidobaldo's closeness to Francesco Maria II and the court.

I.2.3 Agostini's *Le Giornate Soriane*

Ludovico Agostini was a man of letters and friend of Guidobaldo.[1] One of his writings, *Le Giornate Soriane*, is particularly interesting for our purpose to comprehend the courtly life in Pesaro and Guidobaldo's involvement in it.[2]
The work has been composed between 1572 and 1574, and describes the courtly life in Pesaro narrating eleven days in summer, lived by six friends, with their promenades between the residences of noble families, chases, *divertissements* as well as philosophical and religious debates. Guidobaldo appears during the fifth day, in company of other important members of the court (Giulio Veterani, Traiano Mario, Fabio Albergati) in an idle boat excursion. Interestingly, we come to know here about another facet of his mathematical work: Guidobaldo is called here (Giornata quinta, paragraph 79) "scholar not less of musics than of mathematics". So let us have a look at these passages (we report, in square brackets, the number of the paragraphs, according to L.S. Firpo's edition):

> GIORNATA QUINTA
> [1] Non si udivano ancora le sonore cicale, ma per li prati gli armoniosi grilli attendevano a far più dolce la piacevolezza dell'uman riposo et ad ingannare i providi villani onde men solleciti talora e non così a tempo, come imaginato si hanno, ritornano a spezzare la durezza della loro matrigna terra; e per le convicine ville s'udivano risonar le valli d'amorose canzoni, che al suono delle strepitose gramole da line sogliono le vezzose contadine cantare. (...)
> [3] Alle cui parole abandonati i letti, tutti in piedi baldanzosi et allegri ci levammo e, poscia che avemmo d'intorno alla nostra fonte spruzzate l'acque e rinfrescatici i visi e le mani, ci ponemmo dietro al nostro

[1] For information on his life and work, cf. Appendix II, chapter II, "Ludovico Agostini".

[2] Cf. L.S. Firpo, *Ludovico Agostini. Le Giornate Soriane*, Roma, Salerno, 2004. Luigi Firpo wrote about it in *Lo Stato ideale della Controriforma*, cit., p. 341: "Descrizione di una immaginaria villeggiatura di sei giovani amici, protratta per undici giornate (primo al 11 agosto 1569) nella villetta roveresca di Soria presso Pesaro e in altri signorili ritrovi dei dintorni. Descrive svaghi e conversazioni, frammettendo di frequente rime amorose e opuscoli morali. Per la data di composizione indizi concordi sembrano condurre al biennio che intercorre fra la metà del 1572 e quella del 1574, non senza correzioni e manipolazioni più tarde. Ne possediamo l'originale in gran parte autografo <BOP, ms 191> e una tarda copia <BOP, ms 1464>."

inventor de' piaceri, il quale arrivato al lito del mare, che vicino era, ci appresentò ad un picciol legno da quattro banchi, con bellissimo artificio coperto di fronzute vitalbe, ch'intrecciate insieme con rami di lauro, sopra a sei colonne che sostenevano il pentacolo, chiamato felce, facevano ad ogni canto loggia; quivi noi dunque montati, fummo a remi condotti sott'al monte Azio, dove volgarmente è la Valugola, luogo molto pericoloso per li non pratici nocchieri, per la contrarietà de' venti che dalle sue insidiose caverne, riflettendo, esala.

[4] Or quivi, così come ne venimmo ammaestrati ciascuno di noi a suo piacere gettò di quelle nasse in mare adescate di carne, et altrove più in alto osservammo certi fasci di ginestre, da prendere gambare e diversi altri pesci, retti da lunghissime viti con li loro signali di legno, che notando sopracqua additano ai pescatori i luoghi ove nascoso hanno le insidie delle loro mani e, di quindi allontanatici, per rivera intorno ad un mezo miglio, ci demmo piacere con la grancaruola, ch'è un ferro, com'una mano distesa, posto in cima d'un'asta con le punte ritorte, perché nella rena si spianino e non affiggano. (...)

[8] E, mentre così carichi tornavamo al lito, vedemmo verso la città, in alto un miglio, che ne veniva una fusta che di corsari pareva; la quale, avicinata che si fu, cominciò a salutarci con una salva d'artiglieria che picciola aveva, che ne fe' stare alquanto sospesi; se bene la qualità del luogo et i pennoncelli del legno che poscia scoprimmo, ogni altra cosa ci arguivano che Tuchi e nimici.

[9] Alla fine, accostatasi alla nostra fregata, e con essa abordatasi, non più né meno che combatter ci volesse, fummo chiari essere li pirati nostri li da noi osservatissimi cavalieri li signori: Guidobaldo del Monte, Fabio Albergati, l'ambasciatore Traiano Mario, il segretario Giulio Veterani, i quali destinato avevano desinare quella mattina in mare; così come poscia, della compagnia gli uni degli altri rallegratisi, tutti ascesi sopra la fusta ch'era dell'arsenale del Duca e, mandato il nostro legno a levar le vivande et a cocere della nostra pescagione, d'indi a una mez'ora, tutt'insieme lietamente ci recreammo.

[10] E perciò che a buon propposito si venne a ragionare della prudenza dell'uomo, della qual materia, parendo al Mario et ai compagni che lo Stupido <uno dei protagonisti del racconto di Agostini>, meglio ch'altri, ne ragionasse, compiuto ch'avemmo di desinare e date l'ancore in un sito dove freschissime aure spiravano, a' preghi di tutta la compagnia egli prese l'assunto a discorrere, ma, trovandosi aderente ad una palata delle molte che l'una dietro all'altra per rivera si trovano, lo Stupido, invaghito da una moltitudine di pesci che vide aggirarsi intorno alle reti di detta machina – che lucerne si chiamano, dove di verno, da ponente si pescano anguille, varoli e cevali, con grandissimo utile di molti nobili, di cui sono le pesche; e di state, voltando le reti

a levante, si prendono d'ogni sorte di pesce che la staggione porta – trattosi subito di barca col seguito del Sventato, fece due mani con le reti che a taglie et a canape si reggono, appiccate ad altissimi legni che sporgono in mare e, per sua buona fortuna, prese un dentale di corona di cinquanta libre e quattro varoli di non mediocre grandezza, oltr'a molti altri pesci minuti di più sorte; poi tutto blanzoso, saltando col compagno nella fregata, cominciò così il suo raggionamento:

De la vita dell'uomo prudente

[11] L'uomo prudente, ch'è regolato dalla ragione, se stesso parimente con facilità si regge; ond'è che viene dai cieli constituito monarca delle virtù, domator de' vizii et insieme (ch'è gran cosa a dire), dominator delle stelle. [12] Della prudenza, però, che dee aver l'uomo per esser veramente uomo, così comandato, ragionerò io oggi; la quale prudenza, essendo una scienza di eleggere il bene e di schivar il male, consequentemente verrà ella ad esser fondata sopra la triangolare base di memoria, d'intelletto e di volontà da providenza contemprata: della prima servendosi per l'osservanza delle cose passate, per reggimento del presente e del futuro di nostra vita; del secondo per discernere il ben dal male et il vero dal falso; e del terzo et ultimo per preparare i fatti nostri prima che ne siamo astretti dal tempo. [13] (....)
[79] Qui ebbe fine il ragionare dello Stupido ch'a tutti sodisfece che l'udirono; e non ci parendo tempo né occasione da por mano agli strumenti da suono, così come propose il Signor Guidobaldo, non men amico e scienziato di musica che di matematica si sia, si cantarono alcuni motetti di Adriano e, quando ci parve tempo da riposar le voci, demmo mano alle loro reti da pescare che tratte si chiamano; et a gara d'alcuni pescatori mercenarii, che da vicino ci stavano, trastullammoci infin al compimento del giorno, dove, avendo noi preso gran copia di pesce, pel più calamari e triglie, ci ritirammo in mare a parimente convivare insieme, sì come la mattina facemmo. [80] Il che finito che fu, ancorché il Veterani facesse ogni sforzo che fossimo condotti infin al lito con la fusta, non parendoci nondimeno né luogo né tempo di più vestirci delle cortesie loro, al meglio che potemmo, ce ne spogliammo. (...)
[83] Et arrivati che noi fummo al lito, licenziammo con quattro fiaschi di vin moscatello li nostri marinari, ch'al porto se n'andarono; e noi, preso il sentiero verso l'alloggiamento, ce ne fummo tutti più contenti delle cose passate, ove, arrivati che fummo, essendo l'ora tarda, ciascuno s'inviò alla sua camera a godere ne' sensuali letti il mormorio delle salse onde che leggermente riperscuotendo i lidi, facevano al son-

no un dolce invito nel maggior silenzio della notte.
FINE DELLA QUINTA GIORNATA

An important confirmation of Agostini's claim about Guidobaldo's occupation with music is given by the following letter from Almerico Almerici to his son Virginio:[1]

> Questi conti della Medula in casa loro fanno recitare un egloga, l'autora della quale è il Montano da Urbino. Si preparano bellissimi intermedii di moresche, autore il S.re Guidobaldo (...).

This independent information about Guidobaldo's dealing with musics reinforces also the reliability of Agostini's account of Guidobaldo's theoretical studies on music. Therefore, the page about music (about the sound of a string) in the *Meditatiunculae*, with high probability did not constitute an isolated study.

Turning to the *Giornate Soriane*, a passage of the ninth day is another testimony of the friendship between the dal Monte and the Giordani family: Guidobaldo's seven sons are described to be on a boat excursion with the Giulio and Pier Matteo Giordani, the former the future first secretary of the Duke, the latter Guidobaldo's closest friend and scientific interlocutor:

> NONA GIORNATA
> [1] (...) [108] E perciò che restava ancora gran pezza di giorno da passare, ci risolvemmo lasciar il legno in libertà del mare e sotto la nostra celiga con voci e con strumenti trattenner Nettuno in armonia fra noi; la qual cosa avendo con molto nostro piacere esequita infin quasi al tramontar del giorno, parendoci tempo di ristorare la sciugaggine delle nostre fauci e l'appetenza de' nostri stomachi, al meglio che potemmo, così in mare come stavamo, levate le tende in discoperta dell'ombra che grata ne dava il nostro monte Imperiale, lietamente in andando al lito a un remo solo, a sobrietà ci recreammo, godendo insieme del piacere che in un brigantino si prendevano alcuni giovani, che pescando con la togna a varoli, se ne tornavano dalla vista delle galee in porto.
> [109] Erano questi: il Signor Francesco Maria et il Signor Carlo <et il> Signor Orazio del Monte, un Ardizio et un Macingo e, puoco dopo, loro sopragiunsero in un piccolo palischermo li Signori Alessandro, Orazio, Uguccioni, Onofrio e Giovanni del Monte, sette fratelli degnissimi ritratti del Signor Guidobaldo loro padre, e con esso loro eranvi il segretario Giulio Giordano et il filosofo Pier Matteo suo fratello.

[1] Cf. BOP, ms 1577, letter number 53; February 9th 1579.

I.2.4 The deaths of Commandino and Minerva Pianosi in 1575/76

According to Baldi's *Vita of Commandino*, the latter passed away on September 3rd 1575.[1] A day later, Guidobaldo informs Giulio Giordani about Commandino's death.[2]

> Molto mag.co come fratello hon.do,
> trovate Valerio Canovaro del Duca che ha commissione di pagar quel che farete far per conto del scattolino e di gratia mandatemelo presto. Desidero che guardiate nell'almanacco e che vediate giusto il dì dell'equinottio, e che in tal dì vediate se nelli orologgi del Conte Giulio la punta dell'ombra va su la linea *aequinoctium* e che in segreto me lo avisiate.
> Il nostro Comandino come dovete aver inteso è morto con mio grande dispiacere, e di gratia dite a m.s Cesar Benedetti che non li rispondo perché il Duca non è qui che è andato a Fossombrone da venere in qua, et va a caccia a Monte Felcino e non si sa quand'egli torni. Al qual bascio le mani et a V.S. Di Urbino alli 4 di settembre del '75.
> Di V.S.
> Come fratello e ser.re Guidobaldo
> dei Marchesi dal Monte

Also Francesco Maria dal Monte must have stayed with Guidobaldo at Urbino in this period, as it can be deduced from the following letter written by the former to Giulio Giordani:[3]

> Molto mag.co S.r mio hon.do,
> V.S. mi facci gratia farsi dare in Casa mia le chiavi delle mie camere et guardare nella tavola grande del mio studio che vi è una orazione del Querino in stampa fatta per l'andata del Duca di Ferrara a Rome et mandarmela su subbito.
> Né sendo questa mia per altro fo fine basciandoLe le mani. Di Urbino li II di settembre del 1575.
> Di V.S.
> Ser.re Fran.co Ma.a
> de' Marchesi dal Monte

Thus, it is probable that they took leave of their master in his last hours. Further, it seems that Guidobaldo (and, apparently, also his brother) stably lived at Urbino

[1] Baldi writes: "Giunta finalmente al colmo l'acutezza del male, essendo d'anni sessanta sei dell'età sua, passò a miglior vita il terzo giorno di settembre nella casa propria", cf. B. Baldi, *Vita di Federico Commandino*, cit., p. 176.

[2] Cf. BOP, ms 426, fol. 147r.

[3] Cf. BOP, ms 426, fol. 73r.

in that period. In fact, Oddi reports, referring to the years of Guidobaldo's mathematical formation under Commandino: "L'Illustrissimo Signore Guidobaldo de' Marchesi del Monte, che in quei tempi si tratteneva in Urbino per conferire i suoi studii con il Commandino, et spesso era alla casa dove lavorava il <Simone> Baroccio (...)."[1]

A year later, Guidobaldo lost his mother. We can deduce her death from two conserved letters between Ranieri dal Monte and Cardinal Giulio della Rovere.[2] Ranieri, worried about his wife's illness, begs the Cardinal to send him his physician "Signor Sant'Agata":

> Ill.mo e Rev.mo S.r e Patron mio sing.re,
> essendo che Domenica fanno oggi otto giorni sopravenissero corti dolori di corpo a mia moglie così grandi che ne fece dubitar assai, et ancoraché in due dì gli cesassero, è restata con tutto ciò sì fiacca e così debole che con molta fatica si può far ch'ella magna, et è ridotta in modo che le cose non passano senza qualche fastidio di tutti noi.
>
> E sapendo per bontà di V.S. Ill.ma e non per alcun mio merito, quanto sempre ha mostrato d'amarmi, La supplico a volermi far gratia di concedermi il S.r Sant'Agata per una sera o due, per il quale mando questo mio a posta, che mi sarà tanto maggior questa gratia che se ne venghi domatina qui a bon'ora' et il tutto si receverà da V.S. Ill.ma per molta gratia e per l'amor singolarissimo. Per il quale si pregarà da noi sempre il S. Iddio che Gli conceda ogni contentezza, et con farLe umil riverenza Le bascio le mani. Di Monte Baroccio li XII d'Agosto 1576.
> Di V.S. Ill.ma et Rev.ma
> Oblig.mo ser.re Ranieri de'
> Marchesi del Monte

The physician's intervention, yet, was in vain, since Ranieri cannot help but report on his wife's death in the following letter:

> Ill.mo e Rev.mo S.r mio e Patrone sing.re,
> poiché ha piaciuto al S.r Iddio di torre una serva a V.S. Ill.ma e che il favor fattomi da Lei col concedermi così amorevolmente il S.r Sant'Agata, dal quale ancora che sia stata fatto ogni amorevole deligenza per darle qualche restoro, non è stato però possibile poterla aiutar in modo alcuno.
> Con tutto ciò resto e restarò sempre obligato alle molte gratie che

[1] Cf. M. Oddi, *Fabrica et Uso del Compasso polimetrico*, cit.; pp. 3-4 of the *Proemio*. We have exposed a larger passage in Appendix I, I.2.1.

[2] Cf. BOP, ms 375 fol. 227r and fol. 228r.

continuamente ricevo da Lei, per le quali non potendo con altro pregare sempre il Sig.r Iddio che Gli conceda tutte quelle consolazioni che più si può desiderar [delti]. Et col farLe umil reverenza Le bascio le mani, riportandomi a quanto V.S. Ill.ma intenderà meglia da esso Sig.or Sant'Agata. Di Monte Baroccio li 14 d'Agosto 1576.
Di V.S. Ill.ma e Rev.ma
Oblig.mo Ser.re Ranieri
dei Marchesi del Monte

Ludovico Agostini sent his condolences to Ranieri dal Monte in this occasion:[1]

Al Signor Ranieri de' Marchesi del Monte,
se il nostro sommo artefice Iddio, a differenza degli animali bruti che mirano la terra, non avesse creato l'uomo con la faccia altera verso il cielo per mostrargli che in cielo et non in terra il suo immortale terminar dovesse, certo che vinta la ragion dal senso et l'uno et l'altra dal suo fato oppressi, come athei increduli dell'essenza di Dio, come Aristippi ignoranti dell'immortalità dell'anima et come Saducei mentitori della non resurrettione de' morti ci dispereremmo nel colmo delle sciagure di questo mondo. Ma poiché uomini siamo, poiché christiani, poiché farisei et non saducei con Paolo siamo.
Di gratio ne' frangenti delle nostre avversità ci sia a memoria che il cielo è fatto per noi, che l'anime nostre, agli occhi de' stolti (come canta la Chiesa) paiono morire, godendo, belle, per la morte il possesso dell'empiree stanze et l'immortal quiete della vita et che dopo non molto tempo, rispetto al tempo dell'eternal giustitia, che non discerne da mill'anni a un giorno, questa nostra carne col suo intiero d'oggi rediviva tornando, glorificata in tutto, se ne andarà in perpetua gloria dove per certo tempo la sua anima sola averà goduto la vista essentiale del suo creatore Iddio.
Ora se queste cose, il mio Signore, penseremmo, se questa verità (come dobbiamo) crederemmo, non per alcun dubbio che, ancorché il colpo sia grave et che raddoppiato sembri, dopo la perdita di una amatissima et meritissima figlia, oggi perdere sì generosa et sì gloriosa consorte, Lucretia et Minerva. (...)
Si consoli perciò V.S. et con esso Lei gli suoi meritissimi figli poiché meglio che noi conoscendo Dio l'ora della salute nostra fuor de' nostri giudicii ci ritoglie dalla calamità di questo mondo.

[1]For the complete transcription of the letter, cf. G. Montinari, *L'epistolario di Ludovico Agostini*, cit., pp.185/86. The biographical information about Guidobaldo and his ambiance, we were able to collect, permitted to date this and other letters of Agostini, cf. M. Frank, G. Montinari, *Ludovico Agostini. Lettere inedite*, forthcoming.

Agostini's condolences permit us to deduce, together with *Le Giornate Soriane*, that he was in friendly relations with the dal Monte family already in the seventies, although the only extant letters between him and Guidobaldo date from 1602 and 1605.

I.3 Guidobaldo's first works, his contemporary activities and the happenings in the Duchy in the early and middle eighties

In 1577, Guidobaldo published the *Mechanicorum Liber*, his first work. In Appendix I.2.1, we have seen documents that seem to constitute the first drafts on this work. In 1579 and 1580, he edited two other works, the first on planispheres and different type of projections, the second on the reform of the calendar. In the first subsection, we expose some documents on the creation of this latter treatise. The successive two subsections furnish documents that illustrate the manifold tasks that Guidobaldo fulfilled besides his mathematical work in a strict sense of meaning: at the Duke's instance, he had to supervise works on the Villa Miralfiore and to control the makes of master-clockmakers. Further, the important position of his family in the Duchy of Urbino and the connected duties are illustrated by the last subsection.

I.3.1 The calendar reform by Gregory XIII and Guidobaldo's poor health

In 1579, Pope Gregory had released a bull in which he requested the Christian sovereigns to make the mathematicians of their dominion develop proposals for the reformation of the calendar. As emerges from the following letter written by Jacopo Mazzoni to Giulio Veterani,[1] Francesco Maria II, however, had not answered to the bull. Thereupon, Mazzoni had been asked to repeat the Pope's request to the ducal office. In this context, Guidobaldo seems to have already been known also in the Vatican milieu. It was maybe Mazzoni himself who highlighted the Marquis as possible candidate for the composing of a treatise on the modification of the calendar.

> Molto mag.co et ecc.te S.or mio oss.mo,
> se bene ora io mi trova in Roma, non ho però spiccata la divotione dell'animo mio da cotesta corte e dal S.or Duca. E perciò sempre ho cercato occasione di ragionarne per potere almeno supplir colla lingua dove forse ho coll'opere mancato. Ora questo mio prurito che veramente è tale ch'ho sempre di parlare del molto valore del S.or Duca,

[1] Cf. BOP, ms 430, fol. 199r/v; December 12th 1579.

è stato cagione ch'altri avendo per quello misurata la confidenza ch'io dovea avere col S.or Duca, l'hanno stimata molto maggiore di quella che i meriti miei richiedano.
Per questo ieri l'Ill.mo <Cardinale> Sirletto fattomi chiamare mi disse ch'io scrivessi costà come N.S. restava con qualche meraviglia che il S.or Duca non avesse ancora risposto al Breve che se gli mandò del Calendario, non essendo oggimai Prencipe di Cristianità che non abbia risposto, o ricevendo il Calendario riformato per commissione di N.S. o proponendo novi modi per riformarlo.
Mi disse di più come egli aveva detto a N.S. che il S.or Duca aveva uomini nella corte per questo affare eccellentissimi, fra quali fu specialmente nominato il S.or Guidubaldo <dal Monte> e che perciò poteva il S.or Duca rissolversi sopra questo negozio megliodi Prencipe d'Europa. Io le promisi di fare ogni cosa et a questo fine ho scritto queste poche parole a V.S. e tanto più volentieri quanto che elle mi varranno per mezzo di ripescarmi nella sua memoria. Avrei quasi ardimento di dire "e in quella ancora del S.or Duca", se questa giunta non fosse troppo arrogante. Ma ** ella si sia, voglio però arditamente dire che niuno può pormi videnza sì ch'io non viva servitore per tutto del S.or Duca.
Viva Ella fra tanto sana e mi tenga nella Sua buona gratia e in quella del S.or Giovanni <de' Tommasi> al quale degnerassi V.S. basciar le mani a mio nome. Di Roma alli 12 di decembre del '79.
Di V.S. m. m<ag>. et ecc.te
Aff.mo servitore
Giacomo Mazzone

In fact, only some weeks later, a Papal brief arrived in Pesaro, repeating the earlier request. One of the catalogues of the ducal archive reports in regard:[1]

> 1580 18 gennaro: Breve del medesimo <Papa Gregorio XIII> col quale ricerca il Sig. Duca a voler intendere l'opinione de' matematici del suo stato, e riferirgli la lor' opinione per la riforma del calendario, che dissegnava di fare, acciò si celebrassero li offiti divini a tempi debiti. Li 18 di gennaro 1580 ut supra.

Guidobaldo, though, must have been in really poor health at this time, as the following two letters testify: in the first one, Silla Barignani writes to Pier Matteo Giordani:[2]

> Mag.co fratello ho.do, (...) direte al S.r Federico de' Marchesi <del Monte>, che gli bascio le mani et prego a volermi donare un poco di

[1] Cf. BOP, ms 443, fol. 50r.
[2] Cf. BOP, ms 425, fol. 204r/v, December 17th 1579.

polvere d'arcobugio, fatta da S.S. Ill.ma perché dovete sapere che qua non ci è cosa buona. Et se venite, arrecatella vosco. Sarete ancora contento basciar le mani in mio nome al S.r Guidobaldo, e condolerVi seco della indisposizione, nella qual intendo trovarsi. (...)
Di Padova il dì 22 di decembre del 1579
Fratello am.mo sempre
Silla Barignani

More explicit is the letter that Duke Francesco Maria II made write to one of his agents at Rome, Baldo Falcucci, with which he sent Guidobaldo's *De Ecclesiastici Calendarii Restitutione Opusculum* to the Pope. Therein, he claims that Guidobaldo had composed the treatise on his instance, under the conditions of his poor health:[1]

Mag.co dil.mo nostro,
dipoiché per Vostre lettere s'intese che al Papa saria piacciuto in ogni modo che si fosse fatta di qua ancora qualche fatica sopra la riforma del Calendario, ci risolvemmo di dar questo assunto al Sig.r Guid'Ubaldo de' Marchesi del Monte, il quale avea fatto in ciò quel tanto che gl'è stato concesso dalla poca salute che ha, et dalla brevità del tempo che gli fu prefisso. Noi mandiamo ora questa fatica sua in man Vostra, ad effetto che abbiate da presentarla al Papa in nome nostro, dicendo a S.S. che per obedirla s'è fatto quanto è stato possibile, essendoci dispiaciuto di non aver avuta commodità di far veder et consultare con altri ancora questa materia come volentieri avvessimo fatto, se a tempo ne fossimo stati avertiti.
Ci sarà però carissimo ch'ella rimanga servita et in ogni caso ne rendiamo sicuri che la S.tà S. si appagherà della volontà nostra sapendo massimamente che di ciò noi siamo stati gl'ultimi ad aver notizia et averla anco molto tardi come Voi sapete. Dio Vi guardi sempre. Di Pesaro ai 26 di maggio 1580.
Francesco Maria R<overe>

I.3.2 The works at Villa Mirafiore

Documents stemming from the year 1583 permit us to reach some insight in Guidobaldo's duties towards the Duke: on the one hand he was called to inspect the construction works of a fountain in the park of Villa Miralfiore, including also the improvement of the water supply.[2] On the other hand, he had to control

[1] Cf. BOP, ms 458, fol. 17r; coeval copy.

[2] About this topic, cf. also L. Fortebuoni, A. Frank-Kiss, *Condotti idrici tra alcune ville roveresche*, in A. Brancati (editor), *L'approvvigionamento idrico a Pesaro dalla sua più antica realizzazione al 2000*, Aspes, Pesaro, 2000, p.164.

that a mechanical clock, fabricated by the clockmakers of the Duchy, functioned correctly.[1]
Let us first turn to the works at Villa Miralfiore. Concerning this matter, we will expose not only Guidobaldo's letter to Count de' Tommasi about his on-site inspection, but also letters between the ducal architect Girolamo Arduini, Count de' Tommasi and Count Giulio da Thiene, in order to give some idea about the background against which Guidobaldo's activities have to be contextualised.

The first extant document between Count Giovanni de' Tommasi and Girolamo Arduini regarding the works in the park of Villa Miralfiore, on the fountain and the fish pond stems from August 1582.[2] As emerges there, in the summer of '83, the efforts to solve the hydraulic problem – the arriving water was not sufficient – were intensified. So on July 14th, Arduini – also occupied in the construction works at Villa Imperiale (cf. "scala lumaca", see also the letter on page 455) – wrote to Count de' Tommasi:[3]

> Molto Ill.r Sig.r mio,
> aspetto con desiderio che V.S. molto Ill.re mi risponda se Sua Alt.za ama più la scala lumaca che de' pezzi. Questo lo dico perché il stantiuolo sotto la lumaca è longo piedi 15 e mezzo et verrà bene in doi pezzi. Sia servito di scriverlo che altramente non posso far altro se non mi dice anco se la porta Le piace verso il portone dell'Imperiale, ove si viene da Pesaro per la strada ordinaria.
> Ier' sera fummo mastro Lazzaro et io a livellare il piano della peschiera, et ritrovo che il letto del fiume è cresciuto dalla prima volta che io lo livellai doi piedi, onde non abbiamo che tre piedi di caduta in trentaquattro canne di distanza dalla pechiera al fiume. Questo ci cagionarà che nel mezo della peschiera non si potrà cavar più profondo di quello che si designava per riddurvi il pescie, quando si volea nettare la peschiera. // La onde sarà necessario far un poco di ridutto da un lato fuori della peschiera, perché riceva il pescie mentreché si scaricherà et nettarà detta peschiera, la quale è fondata tutta all'intorno, et è alta la muraglia da quattro piedi sopra il piano. Del resto il tutto processarà benissimo.
> Mastro Gio. Ant. desidera a buon conto cento scudi poiché ne ha, tra la materia condotta et quello posto in opera, in essere per maggior valore. Con basciarLe le mani con tutto il cuore me Le raccomando.

[1] Guidobaldo had attended to studies on gnomonics as the *Mediatiunculae* show. Further, he was an expert of the construction of sundials, as Muzio Oddi tells us. He was, thus, able to control, by means of his sundials, the functionality of the mechanical clocks, prestigious objects fabricated at Pesaro and Urbino.

[2] Cf. BOP, ms 434, fols. 21r-22r.

[3] BOP, ms 434, fol. 47r/v.

Di Pesaro alli XIIII di luglio 1583.
Di V.S. m. Ill.r
Aff.o ser.re
Hiero.mo Arduino

Also Count Giulio da Tiene was involved in the planning of the works at Villa Mirafiore, as emerges from one of his letters, written on the 8th of July:[1]

Molto Ill.re Sig.r mio oss.mo,
per maestro Marcantonio Scarpellino da Ogobbio ho veduto quanto V.S. mi avisa, et subito mandai a pigliare il modello di gesso del vaso della fonte di Miralfiore, et l'ho mostrato a detto maestro Marcantonio, dal quale Ella potrà intendere il suo parere. Quando egli è giunto a Pesaro già io avevo fatto fare un modello secondo l'intentione mia dal giovane di m.s Giovanni scultore di Sua Alt.a con la giunta agli otto pezzi di marmo che ora sono nel vaso fatto. Il quale modello lo darò domatina, che è sabato, ad un mulatiero della corte che lo porterà ad Urbino, et doman'a sera sarò anch'io costì, se a Dio piacerà, dove potrò poi ragionare con Lei di ciò commodamente. Intanto Le mando la pianta del vaso come a me pare che si possi ridurre ingrandendolo di sette piedi di diametro nel suo vasco, et con le misure come Ella potrà vedere per la scala de' piedi et once.
Io l'ho fatto con la meno disgratiata forma che a me sia stato possibile, con quelle portioni di cerchi fra l'un pezzo et l'altro, overo con un puntone, come La vede, che fanno i punti in quelle portioni di cerchio; a me piacicono più li tondi che le punte, come anche a m.s Giovanni scultore et a maestro Marc Ant.o come egli dirà a V.S. Io ho pregato detto m.s Giovanni et mastro Marcant.o che volessero dire se altro a loro parere più a proposito per detto vaso, ma mi dicono che non sanno trovare altro. V.S. nondimeno si potrà adoprare Ella con esso loro.
Nel modello si vedranno nella mettà di esso le punte, et nell'altra li tondi che si giugnono. Ha veduto anche il vaso di marmo detto maestro. Al quale ho parlato del prezzo della sua fattura, quando la forma del vaso piacesse // a Sua Altezza Ser.ma, et prima mi son consigliato et inteso il parere di m.s Giovanni, al quale come anche a me considerata ogni fattura ci pareva quasi che egli dovesse adimandare quanto si è pagato il vaso fatto di marmo, poiché ha da rifare otto pezzi maggiori delli fatti, rifare la pila di mezo, et il fondo del vaso che sarà maggiore et li scalini maggiori, se bene non vi va se non lo stalino solo. Egli come l'ebbi ricercato che dicesse quanto gli pareva che meritasse la sua fattura, mi dette per risposta ch'egli si

[1] Cf. BOP, ms 434 fols. 79r-80r.

rimetteva del tutto in Sua Alt.a. Io dissi che bisognaria che dicesse appunto quello che adimandava, egli mi rispose che gli pareva di meritare quanto s'era pagato il vaso. Al che io risposi che per allora non voleva risposta risoluta, ma che ci pensavo la notte seguente, et che si mettesse alle cose del dovere se pensava volere lavorare egli detto vaso. Nel qual tempo abbiamo pensato m.s Giovanni et io che non dovesse adimandare meno di 250 scudi o all'ultimo 200. Insomma questa mattina li ho dato questa risposta con tre partiti. Il primo de' quali che farà la giunta al vaso secondo il modello che V.S. vedrà, senza la pila di mezo, con li scalini davanti diritti, senza risalti per scudi centoventicinque, con la pila di mezo rifatta secondo il garbo et forma della fonte che si rifacesse per scudi centocinquanta, et se di più si voranno li scalini con la forma et andare della fonte per scudi cento settantacinque: ma che con tutto ciò si rimetterà sempre a quanto parerà a Sua Alt.a Ser.ma.
A m.s Giovanni // scultore et a me pare che si sia messo alle cose del dovere. V.S. potrà con quello che ho scritto io fargli quelle reppliche che Le parerà, a me pare una buona persona et niente tirato.
Altro non dirò per ora, avendo a parlare domandi con V.S. dove meglio potrà intendere il mio parere. Et Le bascio la mano, et me Le raccommando. Agli 8 di luglio 1583 di Pesaro.
Di V.S. molto Ill.re
Affett.m ser.re
Giulio da Thiene

In the progress of the construction works Guidobaldo was called for an expert's inspection: so, Arduini wrote to Count de' Tommasi on the 1st of September:[1]

(...) Siamo stati il S.r Guid'Ubaldo et io et mastro Lazzaro al Barchetto. Et infatti mastro Lazzaro assicura che l'acqua montarà sicuramente et gettarà la mettà a Mirafiore, et l'altra parte sopra il terrapieno per il mezo di quelle chiavi come dissi a Sua Alt.z Ser.ma. Et abbiamo anco livellato che dal dado del ponte ove si dee pigliar l'acqua sino al piano del terrapieno l'acqua deve ascendere piedi 22 et averà di caduta da detto piano sino al piano del barchetto nanti la casa piedi 30. //
Andai ieri a Mirafiore et ho misurato le conservette che sono due, et tengano ognuna di loro ottanta some di acqua, et il piano dell'acqua andarà alto dal piano di terra piedi 7, et oggi si darà ordine per domani di veder l'effetto che faranno, et così di quella se non si sodisfa di quanto si doverà fare.
Se ne viene parte de' fabricatori tutti paccorosi: perché dubbitano che

[1] Cf. BOP, ms 434 fol. 58r/v.

non le sia tolto il boccone, avendole detto che vi è che si offerisse far la fabrica per 250 scudi meno, et Le mando li capitoli; che è quanto li ho potuto tirrare. Con basciarLe le mani mi raccommando alla Sua gratia. Di Pesaro al primo settembre 1583.
Di V.S. molto Ill.re
Aff.o ser.re
Hier.mo Ard.o

The same day, Arduini sent another epistle to Giovanni de' Tommasi, adding some points he had forgotten to report in the precedent one:[1]

Molto Ill.r Sig.r mio oss.mo,
mastro Pietro sarà lo apportatore di questa, il quale non ha ricusato punti di servire Sua Alt.a.
Mi ero scordato di dire a V.S. molto Ill.re che il condotto di legno fa gran danno, et l'acqua non viene più a Mirafiore, et è nel luogo medesimo ove ultimamente è stato accommodato di m.ro Stefano; se Le pare lo farò accommodare. Perché l'acqua si sparge tutta nel piano, che sarà con pochissima spesa, di due opere a scaricare l'acqua in doi ore, et con doi o tre giulii si accommodarà, et l'opere si potranno pigliare nel luogo poiché sono in fatto. Et Le bascio le mani, di Pesaro al primo di settembre 1583.
Di V.S. molto Ill.re
Ser.re aff.o
Hier.mo Ard.o

Regarding Guidobaldo's on-site inspection we have notice also through a letter sent by himself to Count de' Tommasi:[2]

Molt'Illustre S.r mio oss.mo,
questa mattina siamo stati al Barchetto, il Cavaliere Arduino e Mastro Lazaro et io. Et ci siamo risoluti che l'acqua potrà andar sul terraglio vicin'alla Porta del Ponte, che se ben il terraglio è più alto che non è la fonte di Mirafiore, nondimeno l'acqua ci andarà. È ben vero che allora la fonte di Mirafiore buttarà meno perché se gli levarà una parte dell'acqua.
Dice poi il Cavaliere che di quell'acqua che uscirà dalla fonte del terraglio, se ne ha da far un'altra fonte nel piano del Barchetto, e quest'è cosa chiara che si pò fare, essendoci di caduta vicino a 30 piedi. Io non mando le misure di quanto l'acqua abbi da montar nel terraglio, né di altra cosa, perché il Cavaliere se le ha portate in scritto e dice

[1] Cf. BOP, ms 434 fol. 61r.
[2] Cf. BOP, ms 426, fol. 155r/v. Published by E. Gamba, *Guidobaldo dal Monte tecnologo*, in "Pesaro città e contà. Rivista della Società pesarese di studi storici", V (1995), pp. 104-105.

che le manderà a V.S.
Siamo poi venuti a ragionamento tutti tre del sito di far una conserva dove l'acqua si possa radunare accioché la fonte di Mirafiore possi gettar altratanto più acqua, cioè farla gettare in 12 ore quello che la getterebbe in 24. Tutti siamo d'accordo che chi la facesse vicino alla fonte che sarebbe meglio, ma perché bisognerebbe far <la conserva in alto> com'un campanile e ci vorebbe // gran spesa, però questa si lascia da parte. Dicevamo per questo che volevamo far detta conserva o in quella possessione dei Frati (credo che siano di Sant'Agostino) per esser in alto il luogo, overo farla più in qua vers'il ponte. Et io gli ho detto che non la faria in nessun di questi luoghi, ma che la farei la su dove è la conservetta che è il principio dove l'acqua comincia a entrar nelli cannoni; perché quello è il più alto luogo che ci sia, e tutti i luoghi sono più bassi di quello. E così l'acqua di lì averà la maggior caduta ch'ella possi aver. Et anche credo che la si farà con minor spesa poi che ne è fatta una parte, et a Mastro Lazaro è piaciuta questa opinione.
Dice poi il Cavaliere che mi ha da mostrar non so che altro a Mirafiore che, come io l'avrò veduto, ne darò conto a V.S.
Non ho potuto far l'officio che La mi scrive con Mastro Piero per esser fuori della terra, ma io l'aspetto sabbato e non mancarò di farlo. Ho poi tenuto la toretta da che V.S. mi scrisse l'altra sua, ma non Gle ne voglio dir altro per adesso perché come torna Mastro Piero gli farò accomodar alcune cosette e poi scriverò in che modo vadano le ore. E Gli bascio le mani. Di Pesaro al primo di settembre del 1583.
Di V.S. m. I.
Serv.re aff.mo,
Guidobaldo de' Marchesi dal Monte

Count de' Tommasi, in his reply to Arduini, accepted the proposals of the joint inspection and told Arduini which measures he had to launch in the following:[1]

Molto m.co S.or mio oss.mo,
poiché il S.or Guidobaldo, V.S. et mastro Lazzaro dicano che l'acqua montarà, bisogna mo' pensare che'l S.or Duca vuoli che si facci il casino del Barchetto, et però conforme al conto ch'Ella mostrò l'altro giorno potrà far i capitoli et veder chi vuol pigliar a farlo, avertendoLa però che non risolva cosa veruna. Le prime non si saranno viste li capitoli et l'offerte da S. Alt.a la quale desiderava anco che nei capitoli si metesse la cosa del tempo, perché vorrebbe che si facesse presto, tanto dunque V.S. essequisca et quanto prima.

[1]Cf. BOP, ms 434, fol. 98r/v: the letter is not dated, by it clearly refers to the conjoint inspection of Guidobaldo, Arduini and master Lazzaro.

> Rimando i capitoli del casino del'Imperiale li quali potrà far vedere a m.ro Fabio[1] se le mancasse cosa veruna che S.A. resta sodisfatta. Et poi stabilir il tutto acciò si possa dar principio a questo fatto.
> Ho visto quello che V.S. mi dice in materia delli condotti di legno li quali, se fanno danno, è necessario a farli accomodare, né intorno a ciò bisognava aspettar altri comm.<andamen>ti. V.S. lo facci dunque et quanto prima. //
> Nelle cose del condotto di piombo che si ha da fare nel ponte, V.S. potrà essere col S.r Guidobaldo et con il campanaro per sapere la quantità di piombo che si arà da far venire da Venetia, che si poi il detto campanaro ci vorrà più oro che si possa *** ne valerimo di lui, se no farmo venire quello da Roma.
> Ho visto quello che mi dice nel particolare delle conservette e il tutto mi piace.
> Di Gio. Tomasi

A series of other letters informs about the further developments. Amongst others, we come to know that Guidobaldo's on-sight inspection was non an isolated action. He had to made also other site surveys:[2]

> (...) Oggi dovevamo essere il S.r Guid'Ubaldo et io con il campanaro et non si è potuto per essere ito fuori, domattina non tmancaremo et rissolvere il tutto et anco che fornisca il cannone di piombo per far l'isperienze delle conserve. (...) //
> (...) La cosa del cavare de' tufi per la peschiera mi pare che se vade alla lunga. La ne facci scrivere un motto al fattore che egli forse ne aspetta un motto la loro, acciò si dia fine alla peschiera, et che Sua Alt.a Ser.ma se la possi godere.
> Fra sei dì si cominciarà il selicato, io ho pensato acciò Sua Alt.a Ser.ma la godi presto, di fare i cannoni di piombo dalla grotta alla peschiera. Arei caro sapere se è servito che si facciano così acciò fornito di murare se le possa poi dar l'acqua più tosto. Con basciarLe le mani Le prego a Dio ogni felicità. Di Pesaro alli V di settembre 1583.
> Di V.S. molto Ill.re
> Ser.re Hier.mo Ard.o

Towards the end of the month, Arduini wrote again to Count de' Tommasi:[3]

> (...) Mastro Gio. Antonio pose le mani a chiudere la strada del Barchetto iermattina, et domani sarà chiusa ova sbocca detta strada alla Porta del Ponte. Et si cavano li fondamenti verso la strada di S.

[1] m.ro Fabio *in interl.* *deletis aliquot verbis*
[2] Cf. BOP, ms 434, fol. 65r/v.
[3] Cf. BOP, ms 434, fol. 70r-71r.

Giovanni. Sin ora non ritrovo persona che vogli la gatta di pigliare a cottimo le finestre, con porte di detto casino, credo che bisognarà darle a mastro Ghirardo: oltre che serve bene non si è posto a mercato fuori dell'onesto.
Ho dato a fare le piane a mastro Ettore Scarpellino a cinque bolognini meno due quatrini, dico le piane de zufi che vanno sopra il parapetto della peschiera.
Alla grotta non si è messo mano: perché pensavo che il molt'Ill.r <Conte de' Tommasi> venisse con Sua Alt.a Ser.a a Gradara, et pensavo a // bocca ragionarLe che m.ro Lazzaro, quando fummo a Mirafiore, andava moteggiando che bisogna far cose regie et dice che egli non vuole manco grandi et grossi li cannoni per quel luogo di quella mostra di cannone, che le porti a Urbino. Et mi vado imaginando alle sue parole che vuol fare li cannoni grandi et grossi come se vi fosse una gran conserva, che dando poi l'acqua a sì gran cannoni con l'acqua delle conservette non abbiano da riuscire, et venghi al suo fine di fare una conserva di novo.
Questo ho voluto dire accioché se la spesa dupplicasse non nasca da me, et acciò che Lei sappia il tutto, se Lei vuole che io facci fare sì come si è rimasto in appartamento ultimamente con Sua Alt.a, La mi favorisca scriverlo, che subbito le farà mettere le mani, et se anco vuole che lassa fare a m.ro Lazzaro, non mancarò di solicitare, faccendole mettere mano subito.
Sono restato meravigliato che essendo stato all'Imperiale a solecitare la scala lumaca, che credo questa settimana sarà stabilita; andando poi a vedere il sito del casino, sono stati levati quasi tutti li pali et li principali, cosa che non sta molto bene et li frati dicono che non ne sanno niente. Con basciarLe le mani me Le raccomando. Di Pesaro alli XXVII di settembre 1583.
Di V.S. Molto Ill.re

<P.S.> Il muro del terrapieno scontro quello del Barchetto è di cattivissima materia dentro, difficile a romperlo, et mette mal conto, perché se ne è fatto la prova; io ne gettarei solo quattro piedi, acciò il terreno potesse coprirlo, et sopra potervi piantar arbori quando si volesse et non lassaria anco tanto allo mare il terreno; et a un bisogno serveria più che mai, oltre che ha ancora li contraforti di dietro, sotto il terreno.
Aff.o Ser.re
Hier.mo Ard.o

Further, it seems that also Carlo Macigni was involved in the construction works: his comment in a letter[1] to Count de' Tommasi, "Creda V.S. che il Cavall.ro Arduerino et io non lasciamo ora di sollecitudine per finire questi pezzi del casino (...)", suggests that he had a similar role to Arduini's one.

I.3.3 Works on mechanical clocks

The Duchy of Urbino was an important centre of the production of precision instruments, particularly of all kinds of mechanical clocks. As from an analysis of the extant documents emerges,[2] Guidobaldo assumed a key role in controlling the makes of the clockmakers of the Duchy, which were then offered to Popes, Cardinals, Kings and Dukes. Let us have a look at some documents in regard.
In the supervision of the clockmakers' handiwork were involved, besides Guidobaldo, again Count de' Tommasi, as the Duke's intermediary, Girolamo Arduini and, obviously, some clockmakers. Arduini writes, on August 30th, to Count de' Tommasi about a clock fitted in a form of a turtle ("tartaruga"):[3]

> Molto Ill.r Sig.r mio,
> giunto a Urbino parlai al Tortorino, il quale mi disse che non vorebbe manco tempo di un mese a fornire la tartaruca ancorché la vista non gli serviva molto, et che non può per otto dì mettersi a lavorare: perché era lì in procinto di mettere per monaca una sua nepote; et questo è quanto ho potuto cavare, oltre li prieghi et com.<mandament>i dettoLi in nome di Sua Alt.a Ser.ma.
> Oggi, che io gionsi qui iersera a vintiquattro ore, andaremo infatti a vedere et rissolvere quanto Sua Alt. et V.S. molto Ill.re mi hanno ordinato. Et Le bascio le mani. Di Pesaro alli 30 di agosto 1583.
> Di V.S. molto Ill.re
> Ser.re Hier.o Ard.o

The following letter between the two, stemming from September 1st, cited already above in the context of the Mirafiore works, reads:[4]

> Molto Ill.r Sig.r mio oss.mo ,
> ieri ebbi la lettera di V.S. molto Ill.re la quale ha ancora fatto maravigliare a me che non Le sia capitato la mia che Le scrissi il martedì mattina. Et Le davo conto che il Tortorino si scusava assai, alegando di non potere così adesso servire Sua Alt.a in fornire la tartaruca per essere venuto a Urbino per far monaca una sua nepote, et che non potea partirsi per diece dì, et che non le serviva più la vista, et che

[1] Cf. BOP, ms 434 fol. 89r.
[2] A study of this topic, conducted together with E. Gamba, is forthcoming.
[3] Cf. BOP, ms 434 fol. 52r.
[4] Cf. BOP, ms 434, fol. 58r/v.

> vorebbe un mese a fornirla, nonostante che glilo abbia commandato in nome di Sua Alt.z pregatolo et persuaso quanto ho potuto. Insomma non si può far fondamento sopra il caso suo.
> Ho anco fatto dare l'orologio al S.r Guid'Ubaldo acciò veda se è giusto.
> (...)

In his second letter of September 1st to Count de' Tommasi, he wrote:[1]

> (...) Ho scritto una bugia, ma non per mia colpa, che ho mandato a dire a mastro Pietro orologiero, che dia l'orologio della tartaruca al S.r Guid'Ubaldo, acciò veda se è giusto; il mastro me ha detto che subbito lo portarebbeno et vi sono poi stato io, et ho ritrovato che mastro Pietro è andato a Imola, et non sarà qui prima che domani. Subito farà io in persona il servitio. // Con basciarLe le mani me Le raccommando. Di Pesaro al primo di settembre 1583.
> Di V.S. molto Ill.re
> Aff.mo ser.re
> Hier.o Ard.o

The same information on the absence of "mastro Pietro", i.e. the famous clockmaker Pietro Griffi in the Duke's service, is contained in Guidobaldo's letter to Count de' Tomasi of September 1st, whose first half we have exposed above on page 453. At the same time, we come to know that in fact Guidobaldo had noticed something that had to be mended:

> (...) Non ho potuto far l'officio che La mi scrive con mastro Pietro per esser fuori della terra, ma io l'aspetto sabbato e non mancarò di farlo.
> Ho poi tenuto la toretta da che Vostra Signoria mi scrisse l'altra Sua, ma non Glene voglio dir altro per adesso perché come torna mastro Pietro gli farò accomodar alcune cosette e poi scriverò in che modo vadano le ore. E Gli bascio le mani. Di Pesaro al primo di settembre del 1583.

Two days afterwards, Arduini wrote to de' Tommasi in this regard:[2]

> Molto Ill.r Sig.re mio oss.mo,
> ho avuto a doi ore quasi la lettera di V.S. molto Ill.re et Le mando quanto La chiede; et io avesse pensato che m.ro Pietro Francese non avesse avuto tutta la cassa, che m.ro Pietro Orologiero fosse stato qui come è venuto questa sera, che ho voluto vedere l'orologio averei anco veduto il resto della cassa, ma per non andarsene in parole Gli mando li doi pezzi che saranno con questa mia, li quali consegnai a m.s Nicolo depp.rio et Le bascio le mani di Pesaro alli III di settembre 1583.

[1] Cf. BOP, ms 434, fol. 57r/v.
[2] Cf. BOP, ms 343, fol. 63r.

The envelope (folio 64, *verso*) reports the label "To the very Illustrious and observed Lord of mine, Sir Count Giovanni. With two golden bottoms of the turtle case".[1] Yet the works delayed, as we can learn from the following letter written on the 27th of September 1583, again by Arduini to Count de' Tommasi:[2]

> Io ho lassato la cura al S.r Guid'Ubaldo che manda l'orologio, il quale è stato fornito questa sera. Infatti l'orefice non può dare fornito le tazze prima delli diece di ottobre, et le sono più che posso al pelo ancorché egli mena le mani et lavoraria no di notte ma m.s Franc.co non li vol dare due libre di candele. (...)

Some details about the artistic elaboration of the clock and its case are given by the following letter, exchanged by the usual suspects (Arduini, de' Tommasi) on October 5th:[3]

> Molto Ill.r Sig. mio oss,
> a Urbino fui con m.s Federico, et con <il mastro de> l'Ebano, et si rissolse quello che occoreva per servitio di Sua Alt.a Ser.ma quanto alla cassa che m.s Federico l'accettò, et solo si rimediò al tellaro del rifratto.
> Io ordinai, prima che partissi di qui per Casteldurante, che il filo di argento che serve a sostentare il battelo et gli annelli fosse accommodato in modo che fosse inchiodato dietro le cornici, et fu accommodato secondo che ordinò Giovanni Jacomo mastro di Ebano, che se avessi avuto tempo, io lo arei fatto fare in Urbino. Ordinai al Porrino che venisse con detto Giovanni Jacomo.
> Io diedi reccapito alle lettere et agli orologgi. (...) //
> (...) Non saria se non bene di mandare a Venetia con questa occasione il m.ro dell'Ebano, acciò riporta con l'ebano l'avorio venuto, che so che vi sarà da dire che l'ebano è il medesimo venuto un'altra volta con l'avorio, e ancor lui cattivo; et così se va, ci chiariremo del tutto con poco spesa. Non so che dir altro, con tutto il cuore me Le offero, bascio le mani et raccommando alla Sua gratia. Di Pesaro alli 5 di ottobre 1583.
> Di V.S. molto Ill.re
> Ser.re aff.o
> Hier.mo Ard.o

In one of these occasions might have been written also the following note to Guidobaldo – unfortunately, it does not report neither date nor sender:[4]

[1] "Al molto Ill.r Sig.r mio oss.mo il Sig.r Conte Giovanni. Con doi fondi d'oro della cassa tartaruca"

[2] Cf. BOP, ms 434, fol. 70r-71r.

[3] Cf. BOP, ms 434, fol. 73r/v.

[4] Cf. BOP, ms. 430, fol. 217r; fol. 210r of the same manuscript is a eighteenth-century copy.

Del Tamburo
Che l'orologio senza l'ore et i quarti, et che sveglia, et che se i quarti sonassero con due campane come il tamburo vecchio, Gli piacerà assai, che vuol che sia con la [spinala] che sia lavorato all'antica, senza inventione, che tiri 30 ore.
Che quanto alla spesa, perché le lancette mostrassero l'ore, et il svegliatore, bisogneria un poco di [scizetto] o medeletto perché non fussero più lunghe o più corte della [perfertine] del tamburo.
Quanto al modello del tamburo, ha da essere come V.S. giudicherà ch'abbi gusto. Et inviarlo a Urbino e in man mia, avertendo ch'è pericoloso il giustar il svegliatolo come è insieme, dove si mostra l'ore et i quarti; nel mandar inanzi et in dietro che non facci sonar l'ore o i quarti senza preaviso.
V.S. dunque potrà far una poliza, avendo inteso apresso poco l'intentione di S.A. L'altro <orologio> di Spagna ha da tirar per il manco le 26 hore, ma se fusse 28 saria meglio, perché Mastro Pietro non vuole dire il vero, et però V.S. l'assicuri che tirano quelle hore che si delibera.
Quanto alla gente, questo Guem è tanto caro che bisognerà che proviamo a chi ci fa meglio partito, ma che mastro Alessandro non ci impedischi perché Gline torneria male.

I.3.4 The dal Monte family at the Duke's service

The following letter testifies that Guidobaldo's duties towards the Duke were not only limited to tasks relative to supervisions of architectural or technical work. As a member of one, if not *the* most important families of the Duchy in those years, he had apparently also executive tasks to fulfil in the Duke's name:
For some, not entirely clarified circumstances, Count Giovanni de' Tommasi has become a *persona ingrata* despite of having once been one of the closest intimates of Francesco Maria II. In 1584, he was put in prison, two years later even executed. From the reported letter, written by Ranieri dal Monte to the Duke, emerges that it was precisely Guidobaldo and his father (with a certain Captain Caccia) who were commissioned to capture the Count of Montebello. Ranieri, after the arrest, assures Francesco Maria II of the loyalty and honesty of his house:[1]

Ser.mo Sig.r e Patron mio col.mo,
alle cinque ore di notte o poco prima ho receuto la lettera di V.A.S. et insieme con Guidobaldo mio figliuolo et con il Capitano Caccia, et con quei più uomini che sia stato possibile, non si è mancato di star all'ordine per recever dentro il Conte Giovanni <de' Tommasi>

[1] Cf. ASF, Ducato di Urbino, Classe I, 259, fol. 159r.

secondo l'ordine che ci vien dato da Lei. Il quale è poi gionto alle sette ore e mezzo in circa, e dal Capitano Caccia non si è mancato di condurlo in Rocca, e di andarvi ancora lui promettendo la solita sua deligenza et io restai a serar la porta[1]. Noi qui non mancaremo di attendere alla città con quella fede et sincerità che conviene all'amorevolissima servitù nostra, et a quanto semo obligati per servitio di V.A., et si provederà di uomini et di quanto farà bisogno.
Et se altro occorrirà, piacerà all'A.V. di comandarci che di fedeltà e di amorevolezza non cedemo a qualsivoglia altra persona di questo mondo, et si recevirà sempre per favore quando La si degnarà comandarci et servirsi di noi liberamente. E facendoLi riverenza Guidobaldo et io Le basciamo le mani che Dio La prosperi con ogni felicità. Di Pesaro li 16 di luglio 1584.
Di V.A. Ser.ma
Aff.mo e devot.mo ser.re Ranieri
De' Marchesi del Monte

Especially the wording "we will not leave to attend to the city <Pesaro> with the reliability and honesty (...) to which we are obliged by the service to Your Highness" is interesting: it suggests that administrative or executive tasks in Pesaro were no isolated case for Ranieri and Guidobaldo.

I.4 The second half of the eighties

I.4.1 1587 – a fateful year for Guidobaldo

The death of Guidobaldo's father Ranieri in January 1587 had notable influence on Guidobaldo's life. He had to address himself to manifold duties his father had attended to until then, like administrative responsibilities or the jurisdiction over his subjects of Monte Baroccio, in the capacity of their new Count. At the same time, he was elected, at his father's place, member of the communal Council of Pesaro. Furthermore, the year 1587 highlights, once more, Guidobaldo's activity as architect in the Duke's service. Let us have a look at the respective documents:

Guidobaldo as Count of Monte Baroccio and his election as member to the Council of Pesaro

The next two documents, though stemming from a chronologically later period, give us some idea of typical administrative activities connected with his new role. The juridical norms provided that the subjects at Monte Baroccio had to ask the count's permission for buying or selling houses or property. Only after a

[1] et io restai a serar la porta *signo posito in marg.*

hearing of witnesses and, possibly the count's *nihil obstat* the business could be concluded. An example of such a procedure is given by the following document:[1]

> Ill.mo Sig.r Conte
> Donna Piera, moglie già di Michele di Biasio da Monte Baroccio, umil serva e suddita di V.S. Ill.ma espone brevemente: a quella che avendo maritata Donna Gostanza sua figlia a S. Lengarino e per le sue dote abbia assignato certi pezzi de terra nella corte di Fano [ansu] fructuarsi sintanto che li darà effectualmente li dinari promessi; e per essere già venuto il tempo, e non tornandoli commodo lassarli detti pezzi di terra, e per suo magior utile e commodo, ha ordinato vendere uno pezetto di terra posta nella corte di Fano a Sabastino di Busca, cum arbori fructiferi etiam [fructiferi], quale vendita serà di molto minor danno che lassare detti pezzi di terra de quali ne recesse assai utile e magior frutto, perché la povera oratrice e vedova; et avendo uno suo figliolo di età da potere prometere al quale detta terra si apartiene come erede per ragione di dominio; ma per essere alquanto semplice per magior iustificazione della ragione del comprator detta oratrice supplica V.S. Ill.ma che si degni ordinar per Suo rescritto che detta vendita si possi fare, nonostante cosa che fosse in contrario; il che facendo lo receverà per gratia e favore da quella. Quam Deus [vult]. //
>
> Che il Podestà s'informi delle cose narrate e trovando che siano vere, col consenso de' prossimi parenti, curatori[2] alla detta vendita, interponga la sua autorità et decreto non obsti et cet.
> Guidob.o Con.
>
> Di Monte Baroccio li 17 di dicembre 1590

A letter to the communal Council of Fano shows us that Guidobaldo had to exercise foresightedness also in agricultural questions: as it is known, the period from 1500-1700, called also Little Ice Age, was characterised by unfavourable climatic conditions that led several times to famine all over Europe. So Guidobaldo had to organize for example, a particularly meticulous harvest of olives by his subjects, as from the letter emerges. This measure should prevent the lake of oil – a case

[1] Cf. BOP, ms 2267, fol. 150 r/v. In this occasion, we want to warmly thank Luca Cangini, employee of the Biblioteca Oliveriana of Pesaro, who has kindly indicated this document to me, which he had recently discovered. In general, I am indebted to him for the numerous suggestions he gave me during the months of my researches at Pesaro.

[2] curatori *super lin.*

apparently occurred at Pesaro and Fano. Their communal representatives asked Guidobaldo and his County consequently for help:[1]

> Ill.ri Sig.ri miei oss.mi,
> mi è dispiaciuto infinitamente intendere nella lettera delle SS.rie V. Ill.ri della mancanza d'olio che si trova in contesta loro città. E tanto più mi accrescie il dispiacere vedendo non poterLi sovenire et servire come tanto sono obligato, sapendo io molto bene quanto vengano favoriti et aiutati quei miei sudditi di Monte Baroccio delle SS.rie V. Ill.ri ne' bisogni loro.
> Ma temendosi là ancora non aver alla bastanza, ancorch'abbi fatto usar molta deligenza in farne far rasegna, se n'è trovato pochissimo; che mi duole veramente [assai di] non poterLi servire come tanto lo desiderarei, sì come non ho potuto ser<vir> anco la [Podestà di Pesaro et i] SS.ri che me n'hanno ricerco, prego l<i SS.ri di> escusar<mi **** et di> comandarmi se mi conoscano [bene] a *** in qualche altra cosa, certificandoLi che sarano serviti da me sempre di core. Et Le bascio le mani pregandoLe dal Sig.r Dio ogni contentezza. Di Pesaro l'ultimo di Sett.re 1597.
> Delle SS.ri VV. Ill.ri
> Aff.mo ser.re
> Guidobaldo dal Monte

Further activities relative to Guidobaldo's position as Count of Monte Baroccio, like the projection of a new communal palace and tower are hinted at in G. Allegretti's *Monte Baroccio 1513-1799*.[2]
On February 17th, at the Duke's explicit behest, Guidobaldo was elected member of the Council of Pesaro, the representative institution of the citizenship, constituted by some 50 members, practically all of noble origin.[3] Let us have a glance at the record of the session in question:

> Die 17 Febr. 1587
> Congregato consilio magnificae civitatis Pisauri de ordine magnifici Domini Malatesti de Malatestis locumtenentis ducalis.
> Nel qual consiglio fu prima dal s.r Guidobaldo Raimondi Confaloniero proposto che fin'al consiglio precedente restò sospeso per mancanza di tempo che non si podde trattare dell'offitio del depositario. Ora

[1] Biblioteca Comunale Forlì, Collezione Piancastelli, Secc. XII-XVIII busta 37. At the centre of the folio there is a hole with dimension of about 1.5 cm x 6 cm: some of the missing words are nevertheless perceptible.

[2] Cf. G. Allegretti, *Monte Baroccio 1513-1799*, Comune di Mombaroccio, Le penne studio editing, 1992.

[3] Cf. ASCP (BOP), II C 1 (Atti del Consiglio 1580-1609), fols. 64v-66r. The archival units of the Archivio Storico Comunale di Pesaro (ASCP) are conserved at the Biblioteca Oliveriana (BOP).

parendoli conveniente che ne raggioni sendo offitio di tanta importanza, poiché sendosi a quest'offitio per consigli passati aggregato il peso di riscotere l'offerte della Mad.a [C.S.] Terenzo, et anco m.s Annibale Bardi depositario mettendo, oltre il non accettare quest'obbligo, in difficoltà anco di non volere ne essere tenuto riscotere li crediti della m.<agnifica> comunità, sì che era necessario farne s.ra ciò qualche determinatione però che il consiglio discorresse.
M.s Annibale Bardi salito in pulpito disse (...).
Il S.r Confaloniere disse poi che ha piaciuto al S.r Dio di chiamare a sé l'Ill.mo S.r Raniero de' Marchesi del Monte quale ha lasciata così nobil pianta ch'è l'Ill.mo S.r Guidobaldo suo primogenito et che il S.r Duca si compiace che il suo luogo in consiglio si dia ad esso S.r Guidobaldo come riferì essere ordine di S.A. Però per servare gl'ordini propose l'infrascritto partito: Chi vuole che all'Ill.mo S.r Guidobaldo p.<rimogeni>to sia dato[1] in Consiglio il luogo vacato per la morte dell'Ill.mo S.r Raniero suo padre di bona memoria dia la palla del sì e chi non vuole la dia del no.
Fu ottenuto il partito sudetto per balle 40 del sì nonostante 3 in contrario. (...)

Guidobaldo in the Duke's service as architect and mathematician

Still little is known about Guidobaldo's activity as architect, but the information come to light in the last years begins to present an increasingly detailed picture of his duties in this regard and his undertaken projects.[2] The sources stemming from the year 1587 are very instructive, as far as this facet of Guidobaldo is concerned. At the same time, two letters reported below reveal that Guidobaldo was conditioned in his work as mathematician, too, by the Duke's wishes and requests. Let us begin with his duties as architect.

Guidobaldo's architectural duties in 1587. One of principal construction projects, wanted by the Duke, was the installation of a new fountain in Pesaro, situated in the middle of the main *Piazza*, in front of the Ducal Palace.[3] The Council Records give us some idea of the proceedings of the works: the required water for the water supply should come from Monte Ardizi.[4] There were old

[1] dato *correxi ex* dia

[2] Besides the documents that have been found in the context of our researches, we want to refer to the studies of D. Trebbi and F. Menchetti.

[3] As the respective entries of the Council Records are concerned, there is the danger of confusion between "Guidobaldo Ramondino", often abbreviated as "Guidobaldo Ram.o", and "Guidobaldo dal Monte".

[4] Pesaro is situated between two hills, one of them exactly "Monte Ardizi", the other is "Monte San Bartolo".

aqueducts on this hill, but it was not clear in which measure they could be used for the new project. The entry of the session of April 29th 1587 reads:[1]

> (...) Detto Sig.r Confaloniere <Tiberio Almerici> raccordò ai Ss.ri eletti sopra la fonte che voglino attendere a questo negotio poiché il S.r Giulio Veterano d'ordine del S.r Duca n'ha fatta parola seco che se ne facci opera, dimostrando S.A. averne desiderio.[2]
> M.s Flaminio Clemente, uno delli eletti, in renga disse essersi colli compagni stabilito per domani d'andare al Monte dell'Arditio per scoprire certi condotti antichi; il che fatto che si tratterà poi del negotio.

The passage suggests, that the works were making only slow progresses at the time, so that the Duke's first secretary, Giulio Veterani, exhorted the responsible council members to approach this task. Now Guidobaldo entered the stage: he was commissioned by the Duke probably to occupy with this problem.

There were various reasons for this step: surely, Francesco Maria II intended to accelerate the proceedings, but he needed also an expert to resolve the technical difficulties.

Further, some corrective works were undertaken at Villa Miralfiore, where Guidobaldo had already been active in 1583. They included, *inter alia*, an amplification of the fish pond. Consequently, also the water supply had to be augmented, which apparently was not possible with the existing water pipes. A part of these works seems to have been connected with a planned journey of Pope Sixtus V through Pesaro.

In effect, the following session of June 2nd reports on a letter written to the Council by the Duke, in which Francesco Maria II had appointed Guidobaldo as the responsible for the construction works regarding the fountain:[3]

> Pisauri die 2 Junii 1587
> Congregato consilio magnificae comunitatis Pisauri de ordine magnifici Domini Malatestae Urbinatis ducalis locumtenentis.
> Nel qual consiglio il S.r Capitano Agostino Monaldi Confaloniero referì che si è avuta risolutione sopra la fonte per lettera di S.A., in particolare della spesa. Ordinò che essa lettera si legesse et da me letta in pulpito.
> M.s Flaminio Clemente salito in renga disse doversi ringratiare S.A. che n'abbi fatta tal concessione et diede conto che si cavarà per questa spesa ogni anno due mila scudi et meglio.

[1] Cf. ASCP (BOP), II C I, fol. 67r/v.

[2] *in marg.* della fonte

[3] ASCP (BOP), II C I, fols. 67v-69r. A marginal note on the *verso* of folio 68 reads "the authority given to the elected <men> for the fountain with the Most Illustrious Sir Guidobaldo de' Marchesi".

M.s Fabio Abbati in renga lodò l'opinione di m.s Flaminio.
Onde sentitesi le renghe sop.<radet>te fu da tutti levandosi in piedi accettato per molta gratia la lettera sudetta prontissimi ad essequire quanto in essa si contiene.
M.s Flaminio Clemente di novo salito in renga, come uno degl'eletti alla fonte, disse il bisogno per tal servitio et s'offerse se fusse più giovene fare più di quello non ha fatto sinora per l'età in che si trova, et concluse che oltre al soprastante sarebbe bene eleggere un proveditore et un depositario di cotal spesa.
M.s Guidobaldo Raimondino, altro eletto alla fonte, salito in renga disse doversi dar rodine di publicare i datii et far altre provisioni conforme alla lettura; et circa li coadiutori lodò l'opinione di m.s Flaminio essortando doversi dare anco due altri cittadini stante l'impedimento dell'Ill. S.r Conte Giulio Cesare, Ill. S.r Guidobaldo et S.r Carlo Macigni. (...)
[fol. 68v] Proponesse[1] il S.r Confaloniere et sentitosi varie opinioni de' SS.ri cittadini fu poi concluso viva voce che li già eletti sopra la fonte insieme coll'Ill.mo S.r Guidobaldo de' Marchesi [nominato/voluto] anche da S.A. debano seguitare l'opera della fonte colla medesima autorità ch'è stata loro data nell'altro partito et come nella lettera ducale oggi letta in consiglio. (...)
[fol. 69r] M.s Girolamo Arditio salito in renga disse che per scoprirsi gl'acquedotti si fanno gravi danni ne' beni dove sono gl'acquedotti: però che sarebbe onesto s'elegessero due uomeni di consiglio ad estimare cotai danni.
One sendesi sentiti l'opinnioni di molti citadini furno viva voce eletti m.s Lud.co Mascellini et m.s Aless.o Piccioni a rivedere et esetimare li danni che si fanno ne' beni per scoprire gl'acquedotti antichi per la fonte da farsi. (...)

This document is rather instructive, as is sheds light on many details of the works: we get to know that the Duke had chosen Guidobaldo, Giulio Cesare Mamiani and Carlo Macigni[2] to approach this matter which was surely connected with the works at Miralfiore. At the other side, the members of the Council, elected responsible for the works on the fountain, seem to have had rather administrative functions: the had to calculate extra-taxes, to esteem the compensation for the damages caused by the construction works, or to resolve the problems relative to the rising prices of bricks, as an analysis of the Council Records shows.
Further, Girolamo Ardizi (not by chance a member of the family Ardizi that traditionally inhabited Monte Ardizi) adverted to the possible damages that could be caused by the works on the aqueducts at Monte Ardizi, and consequently to

[1] *in marg.* Autorità data agli eletti sopra la fonte coll'Ill.mo S.r Guidobaldo de' Marchesi
[2] Carlo Macigni had been involved in the works at the Villa Miralfiore in 1583, as well.

the need of compensations. One of the implications of the works were that the respective terrain could not be cultivated in the (long-lasting) construction phase.

Also in Guidobaldo's correspondence we find traces of this task. A serious of letters written to him by Giulio Cesare Mamiani, the Duke's intimate (whose letters, not by coincidence, are written from Villa Imperiale and then from Urbino where the Duke was staying, respectively, in those periods), shows his interaction with the Ducal court and gives us information about the proceeding of the works. The first letter, dating from June 19th, reads:[1]

> Al S.or Guidobaldo del Monte,
> il Signor Duca m'ha ordinato ch'io scrissi a V.S. per intender da Lei che tempo ci vorrà per accomodar le fonti secondo la nota data da V.S. Sarà dunque servita farmelo sapere quanto prima.
> Che senza dirLi altro Le bacio le mani et Li resto quel servitore di sempre col pregarLi da Dio ogni maggior contento. Dall'Imperiale alli XIX di giugno 1587.
> <Giulio Cesare Mamiani>

The following letter, in contrast, is about the works at Villa Miralfiore. Again, Mastro Lazzaro seems the technical supervisor of the works there, as in 1583.[2]

> Del far il condotto alla peschiera che propone Mastro Lazzaro, staremo a vedere che risoluzioni farà il Papa intorno alla sua venuta qui per Padova; intanto si potrà far l'altre cose, com'anco partito che sarà il Sig.or Duca per Urbino far cominciar al lavoro che Lei raccorda.
> Et restandoLe con questa fine il solito servitore di sempre, Le bacio le mani. L'auguro ogni maggior contento. Dall'Imperiale il primo luglio 1587.
> <Giulio Cesare Mamiani>

The connection of Guidobaldo's two duties, regarding respectively the fountain and the works at Miralfiore, emerges from the next letter.[3] Mamiani advises to use the pipes fabricated for the works concerning the fountain, for the water supply of the grotto at Miralfiore:

> Al Sig.or Guidobaldo de' Marchesi del Monte,
> ho avuto l'informationi del fiume et del scoglio la quale farò vedere a S.A. Quanto alle cose della fonte, non si essendo ancora certo che'l Papa sia per venire o no, V.S. potrà far accomodare l'altre cose tutte per poter poi in caso della venuta ricorrere a risarcirle di quel modo

[1] Cf. BOP, ms 211, fol. 108r. The present letter, similarly the following ones, is part of Mamiani's letterbook. This explains the informal titles and endings of the letters.

[2] Cf. BOP, ms. 211, fol. 102 r/v. The first half of the letter will interest us in a little while, as it testifies also "scientific tasks" for Guidobaldo wanted by the Duke.

[3] Cf. BOP, ms. 211, fol. 131 r/v.

ch'Ella ha pensata. Perché se ben non si darà adesso ordine che si faccino quei tomboli per rifare i condotti della grotta, si potrà valere di quelli che si fanno per la fonte di Pesaro, che alla Communità poco importara che si prestino, poiché se gli renderanno in tempo da // potergli metter in opera.
Di tutto mi rimetto al Suo prudentissimo giuditio, et Gli bacio le mani. Che il Sig.or Dio La rendi sempre felicissima. Di Urbino alli VI di luglio 1587.
<Giulio Cesare Mamiani>

The successive letter is the last one conserved between Guidobaldo and Giulio Cesare Mamiani. One can intuit Guidobaldo's authority at the court, when Mamiani agrees "that it shall be done what You tell, since it is approved as a necessary thing by Your Lordship":[1]

Al medesmo <Guidobaldo>,
Io ha dato conto al Signor Duca di quanto V.S. mi scrive nel particolare di alzare doi piedi la peschiera. S.A. m'ha ordinato che io Le scriva, che poiché è approvato da V.S. per cosa necessaria, che si faccia quanto Lei raccorda.
Due cose in questo proposito m'ha l'Alt. Sua detto, ch'io dichi a V.S.: l'una che Mastro Lazzaro ha d'avvertire che tutte quelle cose che non sono state fatte da esso, che si rifaccino di nuovo. L'altra che s'abbia in consideratione che con // alzar detta peschiera, si faccia che'l scoglio getti bene et meglio che non faceva quando partimmo da Pesaro, che a gran fatica l'acqua stappava fuori.
DicendoLi anco di più, che non si alteri maggior spese, perché come Lei sa quella della libraria è grande, oltre alla <Villa> Vedetta, et l'altre che si fanno.
V.S. che è prudentissima so che sarà per avvertire a tutte queste cose, et in particolare far che a Mastro Lazzaro non venghi volontà di accrescere altra spesa di quella che si fa sin'ora. Resta solo che V.S. dia sollecitudine ad ogni cosa acciò al tempo detto sia finito il tutto che così comanda il P.rone Ser.mo. Che con questo fine Gli bacio le mani, pregandoLe felicità contenta. Di Urbino alli XXV di luglio 1587.
<Giulio Cesare Mamiani>

Guidobaldo's following letter to Giulio Veterani hints at a third construction site for which Guidobaldo seems to have been responsible: construction works at the port.[2] To my knowledge, this is the only document until now that testimonies

[1] Cf. BOP, ms. 211, fol. 132r/v.

[2] The port of Pesaro was subject to frequent maintenance and modification operations: there were building projects in the fifties of the sixteenth century. Also in the second decade of the

Guidobaldo's involvement in this regard. Hence, further in-depth studies about this would be very welcome:[1]

> Molto mag.co Sig.r mio oss.mo,
> Questa mia sarà solo per darGli nuova come si è comincio a lavorar al porto.[2]

Bonamini's manuscript *Cronica di Pesaro* informs us about the successive works at the port, inclusive Niccolò Sabbatini's and Francesco Maria (II) dal Monte's involvement:[3]

> 1613 4 marzo: Fu dato principio ai lavori del nuovo porto in linea retta (come è presentemente alla fine del secolo XVIII). Fu comoinciato lo scavo e si batterono i pali essendo Soprintendente Generale a tutto il lavoro il Capitano Silla Baregnano pesarese, gentiluomo del Duca, e celebratissimo nell'arte militare. Discorsi di lui nell'Indice de' *Uomini illustri pesaresi*, ed ivi potranno vedersi le sue notizie.
> A lui fu aggiunto il famoso Nicolò Sabattini patrizio pesarese, noto già al mondo letterario per la bell'opera che dette alla stampe col titolo *Pratica di fabricare sciene*. Anche di lui si vegga il citato indice. Tanto asserisce il Macci <in> *De Portu Pisauri* che può vedersi autografo presso me, ed altretanto notò l'Olivieri nelle sue *Memorie del Porto*.
> Io tuttavia vado sospettando che non essendo riuscito questo porto di quella perfezione voluta dal Duca, fosse mutato il Sopraintendente Baregnani e l'Architetto Sabatini, giacché un nostro autore, D. Berardino Tontini, sotto l'anno 1614, lasciò scritto che il Breccia da Sant'Angelo in Vado a suo cottimo scavò il porto che ne fece le palate Giovanni Cortese da Pesaro, e che soprastanti di tutto il lavoro del porto furono il Marchese Francesco Maria <(II)> del Monte, Marchese di Monte Baroccio, e M.s Almerico Bacchio da Pesaro, come ivi si legge alla pagina 8 dell'originale manoscritto.
> Guid'Ubaldo II nostro Duca meditò già un nuovo porto di mare a

seventeenth century ample works were realised: The involvement in these works of two figures from Guidobaldo's vicinity, his disciple N. Sabbatini and his son Francesco Maria (II) dal Monte, seems to confirm the former's role in rebuilding the port at the end of the sixteenth century. In-depth researches on this topic would be welcome, for they could furnish interesting details on this type of Guidobaldo's activities. For further informations on the history of the port of Pesaro, cf. G. Pedrocco (ed.), *Immagini e storia del porto di Pesaro*, La Pieve, Verucchio, 1986.

[1] Cf. BOP, ms. 426, fol. 157r; August 12th 1587.

[2] The rest of the letter is reported below, as is regards another facet of Guidobaldo's duties, namely the edition of Pappus' *Collectiones Mathematicae* in continuation of Commandino's incomplete works.

[3] Cf. BOP, ms 966, p. 191

> Pesaro, e ne fece il modello, che portato a Venezia presso Gio. Giacomo Leonardi fu molto lodato; Bartolomeo Genga, Vasari a <pagina> 236.

The Duke's influence on Guidobaldo's mathematical work

The just cited letter (p.469) is at the same time a prove that Guidobaldo was involved in the edition of Pappus' *Collectiones Mathematicae*, left incomplete by Commandino because of his death, although Guidobaldo's name does not appear in the edition, released in 1588. Once again, it was the Duke to commission Guidobaldo to do this. So the latter gave account to Giulio Veterani, the Duke's first secretary, of the proceedings of the revision and the print. Hence, the document is a confirmation of what Baldi claimed in the *Vita di Commandino*.[1] The letter reads, immediately after the passage reported above:[2]

> Et anche per dirLe che fra un mese, e forsi manco, sarà finito di stampar il sesto libro di Pappo. E perché (come V.S. sa) si aspettava il settimo libro in greco da Roma per poter accomodar questo latino, desidero di saper se verrà perché non bisognerebbe, come sarà finito il sesto libro, far poi trattener la stampa.
> Ma se non verrà io farò stampar questo settimo come si ritruova, e lasciarò li spatii in alcuni luoghi dove manca qualche cosetta, la qual darà credito che quelli che leggeranno s'immaginaranno che'l Comandino non gli ponesse l'ultima mano, e che quelli che l'hanno fatto stampar non hanno voluto alterar pur'una sillaba di quello che ha lasciato scritto il Comandino. Come si dirà nella lettera dedicatoria.
> E Le bascio le mani. Di Pesaro alli 12 di agosto del 1587.

The edition of Pappus, initially, was not thought to be consigned to Guidobaldo. In fact, at first, the Venetian mathematician Francesco Barozzi had received by the Duke the task to complete Commandino's translation.[3] So, on October 25th 1586, the Duke's ambassador Bernardino Borgarucci confirms the receipt of the first of two cases with Commandino's documents:

> Resi la Sua <lettera> al Cl.mo Barocci, dandoli conto dell'esser avuta una cassa delle fatighe del Comandino, et aspettassi l'altra con prima imbarcazione.[4]

[1] The abbot of Guastalla wrote there: "<l'incarico di curare l'edizione delle *Collectiones Mathematicae*> fu dato (...) a Guidobaldo (...) che lo fece stampare nella città di Pesaro."

[2] Cf. BOP, ms. 426, fol. 157r.

[3] For a detailed reconstruction of the Barozzi-affair in context of the planned publication of Commandino's translation of the Pappian *Collectiones Mathematicae*, cf. L. Passalacqua, *Le "Collezioni" di Pappo: polemiche editoriali e circolazione di manoscritti nella corrispondenza di Francesco Barozzi con il Duca di Urbino*, in "Bollettino di Storia delle Scienze Matematiche", XIV 1 (1994), pp. 91-156.

[4] This and the following citations on this topic are taken from L. Passalacqua.

An influence and other minor problems hindered Barozzi starting immediately the works on the translation. Yet, in the meantime, something had happened that changed the situation completely: less than two months later, on December 6th, Barozzi was constrained to send all Commandino's materials back, as we learn from another letter between Borgarucci and Duke Francesco Maria II:[1]

> Resi la Sua <lettera> al Cl.mo Barozzi con buon ordine di rimettersi in cassa l'opere del Comandino, senza diminution alcuna, et si rimandaran ben confezionate con prima creazione di barca secondo l'ordine.

It must have been in this period, after the arrival of Commandino's materials, that Guidobaldo was commissioned to cure the edition of the translation of the *Collectiones Mathematicae*.

Another prove for the interference of Guidobaldo's scientific work and the Duke's interests is the following letter, sent again by Giulio Cesare Mamiani, where the Duke's intimate asks Guidobaldo to amplify a treatise on a clock, maybe a sundial and written by the Marchigian mathematician apparently at the Duke's instance, with further information:

> Al S.or Guidobaldo del Monte,
> ho fatto vedere a S.A. la scrittura che V.S. Ill.ma ha fatto sopra l'orologio che va nel calamaro a fiume, et l'Alt. Sua è restata molto sodisfatta. Ma desidera che vi si aggiungi l'informatione delle cose che sono nel calamaro sudetto, cioè l'orologio da sole, il stucchio, il candeliero et tutto quello che vi è. Sia dunque contenta V.S. di far tutto questo conforme alla mente di S.A. // et il tutto più chiaro che si può, et mandarla quando avrà commodità.

A possible context of this story might be the following: the Duchy of Urbino was noted for its fabrication of scientific and precision instruments. They were frequently sent to outstanding diplomatic contacts, as Popes, Dukes and Cardinals.[2] As the the instruments were highly complex devices, the presentees required a kind of "instructions for use" – without them, the presentee had to recur to a mathematician for an explication: a similar case is described for Giovan Battista Benedetti.[3]

[1] Again, for a detailed reconstruction of the Barozzi-affair, cf. L. Passalacqua, *Le "Collezioni" di Pappo: polemiche editoriali e circolazione di manoscritti nella corrispondenza di Francesco Barozzi con il Duca di Urbino*, cit.

[2] An in-depth study on this topic together with prof. E. Gamba is forthcoming.

[3] Cf. C.S. Roero, *G.B. Benedetti and the Scientific Environment of Turin*, in "Centaurus", XXXIX (1997), pp. 37-66.

I.4.2 Guidobaldo's *annus mirabilis*: 1588

The year 1588 had a crucial meaning in Guidobaldo's scientific life. So, he published the *Paraphrasis* terminated the revision works of the *Collectiones Mathematicae*. Further, he came to learn the young Galileo, which meant the beginning of a fertile scientific contact between the two. Finally, his excellent relations of himself and his family to the Tuscan court were underlined by his appointment as *Visitatore* of the Tuscan castles, by his son Orazio's appointment as *Generale dell'arme* of the Pisan State and, last but not least, his brother's consecration as Cardinal (supported by the Medici court).

The first contacts with Galileo

It on the first days of the year 1588 that the young Galileo wrote a letter to Guidobaldo, exposing him some theorems concerning the Archimedean theory of *centre of gravity*. Guidobaldo is impressed, from the very beginning, by Galileo's talent. In the present paragraph, we expose the first letters exchanged between them, given the importance of their scientific contact.
Here is Guidobaldo's reply to Galileo's approach:[1]

> Molto mag.co Sig.r mio hon.do,
> si scusa V.S. nella sua che troppo liberamente e con troppo ardire viene con la sua lettera, a me certo gratissima, a ritrovarmi, com'Ella sia per fastidirmi. Ma non si avvede che con troppo ardire et troppo mi lauda, fuori di ogni mio merito. Ma in questo conosco che ha voluto notificarmi l'animo Suo, certamente verso di me troppo cortese, dove io L'ho da ringratiar di due cose:
> L'una dell'avermi troppo onorato et esaltato, l'altra del favore che mi ha fatto a mandarmi il Suo teorema, che veramente Gliene resto obligatissimo et a me è piaciuto assai; massime che V.S. ha voluto imitar Archimede nelle due ultime propositioni *De Aequeponderantibus*, il qual libro fra pochi giorni sarà mandato fuori da me comentato. Che se ben il libro d'Archimede non ha troppo bisogno di comento, non ho però potuto mancare di non farlo. E perché sarà fra pochi giorni finito di stampare, io ne mandarò uno a V.S., se però saprò dove Ella sia per essere, sì che La prego ad avisarmene.
> E perché nella Sua mi dice di aver altre cose sopra i centri della gravezza, a me farà sempre favor grande a farmi partecipe delle Sue cose, che per questo saggio che mi ha mandato non possono se non essere di esquisita dottrina; dalle quali so che non potrò se non imparar assai, avendo conosciuto in questa una esquisita et profonda scienza, et un modo di trattar molto bello et assai succinto e breve. //

[1] Cf. BNCF, ms Gal. 88, fol. 9r/v. The letter is published in Galileo, *Opere*, vol. X.

> Fra alcune lettere che molti giorni sono occorsero fra il Padre Clavio et <me>, io le scrissi che l'ultima <proposizione> del Commandino *De centro gravitatis solidorum* non era buona per non esser universale. Il qual Padre mi mandò poi la sua dimostratione assai diversa da questa di V.S. Et ho avuto caro che questa sia stata buona occasione di aver avuto a conoscere, almeno per lettere, V.S. dove si pò assicurare di aver uno che in ogni Sua occorrenza non lasciarà occasione di servirLa. Sì che La prego con tutt'il core a non restar di comandarmi liberamente, e Le bascio la mani. Di Pesaro alli 16 di gennaro del 1588.
> Di V.S.
> Ser.re, Guidobaldo
> de' Marchesi del Monte

The respect with which Guidobaldo answers to Galileo ("from Your things (..) I can but learn a whole lot, as I have recognised in it a exquisite and profound science, and an approach that is very nice, succinct and short.") is even more astonishing if we consider their respective positions in the scientific community: Galileo was a fameless nobody, while Guidobaldo was among the most reputed scholar of Italian mechanics of those times.
His promise "not to leave out any occasion to serve" Galileo "in every need" was not a vain one: it was to be he who, with the help of his brother Cardinal dal Monte, contributed in a decisive way to procure Galileo the professorships at Pisa and Padua.
Galileo, in the meantime, had sent other demonstrations to Galileo, as emerges from the next letter, written on March 24th. With it, Guidobaldo sent him an exemplar of the just printed *Paraphrasis*, as he had announced in the aforesaid letter:[1]

> Molto mag.co Sig.r mio,
> Confesso la mia negligentia in esser stato troppo a risponderLe, ma mi sono lasciato trasportare dal tempo, che volevo mandarGli il libro <*Paraphrasis*> il quale è apunto finito di stampare adesso. Io conosco benissimo che V.S. non ha punto bisogno di questo comento, ma il libro è fatto per i principianti. E non so se nella praefatione del secondo libro io sarò stato troppo arrogante in esser contrario a Eutocio, a Pappo et a molti altri moderni, ma io ho voluto pigliar la parte di Archimede più che io ho potuto. Averò caro di saper il Suo giudizio quale stimo sopra ogni altro.
> Poi La non mi poteva dar la miglior nuova che di sentire che Ella sia per passar di qua, che questo lo desidero infinitamente. Ma non voglio che La si fermi qui da me un giorno solo, e La prego a non pentirsi di

[1] Cf. BNCF, ms Gal. 88, fol. 13r. The letter is published in Galileo, *Opere*, vol. X.

non mi far questo favore di venire qui da me, che la casa mia voglio che sia sempre Sua.
La Sua dimostratione ultima che mi ha mandato mi ha piaciut'assai.
E Le bascio le mani. Di Pesaro alli 24 di marzo del 1588.
Di V.S.
Ser.re, Guidobaldo de'
Marchesi del Monte

So, three months after that the two had got to know each other by letters, Guidobaldo did not hesitate to invite the Tuscan mathematician to his home, he "desired that infinitely". And he immediately specified that this invitation was not limited to "one day only", and offered him his house "as always Yours". A rather rapturous invitation... it illustrates the esteem that Guidobaldo brought on Galileo: we are ignorant if Galileo really passed in that occasion. With all probability, the two met at least in the summer of 1592 and performed mechanical experiments together.
The following letter of the 28th of May, shows us the reception of the *Paraphrasis* by Galileo. Further, the letter testifies the first attempts to support Galileo in the research of a academical position. Moreover, Guidobaldo exhorted the young mathematician to continue to attend to his studies on the centres of gravity. In the meantime, Guidobaldo thought to have recognised an error in another demonstration that Galileo had sent:[1]

Molto mag.co Sig.r mio,
ho ricevuto due Sue lettere che mi hanno data grandissima satisfatione. Credo che per la Sua modestia dica che Gli piace il mio libro <*Paraphrasis*> che Gli ho mandato, ma La prego quanto posso che mi vogli avvertire qualche cosa sopra esso perché io ho ancora tutti i libri in mano, e mi sarà facil cosa a coreggerlo dove bisogna. E di grazia non manchi di farmi questo piacere.
Io Le mando la lettera per Monsignor mio fratello <Francesco Maria dal Monte>, La gliela dia Lei medesima e spero che per quello che toccarà a lui non mancarà di aiutarLo; avendogl'io scritto in modo che credo che conoscerà il Suo valore et la Sua dottrina avendogli io scritto la verità.
La prego a non mancar di attendere a queste cose del centro della gravita che ha cominciato, essendo cose bellissime e sottilissime. Ho veduto il Suo lemma, e per dirGli liberamente il parer mio, dubbito che *petat principium*: perché nella dimostratione dove dice "Verum centrum omnium est X, quare X eadem ratione dividet BA et AD lineas" pare che si possa negare questa conseguenza. Percioché si potrebbe dire forse che la libra AD sarà divisa non in X, ma in un altro

[1] Cf. BNCF, ms Gal. 88, fol. 16r/v. The letter is published in Galileo, *Opere*, vol. X.

punto nella proportione che ha BX et XA. La detta conseguenza sarebbe vera se, pigliato il punto X dove si voglia, ne seguitasse // sempre che BX a XA fusse come AX a XD, il che è falso. Seben alcuna volta pò esser vero cioè quando BX sarà dupla di XA, perché allora AX sarà dupla di XD; che se fusse AB divisa in sei part'eguali, BX saria 4, XA 2, XD 1. E però par che la Sua dimostratione *petat principium*. Ma però mi rimetto a più prudente giuditio e massime al Suo.
Io poi desidero che mi comandi che certo ho grandissimo desiderio di poterGli far ogni servitio, e se bisognarà che io replichi altre lettere, non resti di avisarmi e di comandarmi liberamente. E Le bascio le mani. Di Pesaro alli 28 di maggio del 1588.
Di V.S.
Ser.re, Guidobaldo
de' Marchesi del Monte

Three weeks afterwards, Guidobaldo rewrote to Galileo, admitting that he had considered the latter's reasoning erroneously as vicious circle:[1]

Molto mag.co Sig.r mio hon.do,
Quand'io scrissi a V.S. intorno a quella Sua dimostratione, di lì a due giorni io mi accorsi dove avevo pigliato errore. Perché nella prima dimostratione, per esser assai succinta, mi parve che avendo avere la medesima proportione BX a XA come AX a XD, che di qui ne seguitasse che X fusse poi centro della gravita di N, O, R, S, T appese in D, I, C, M, A; ma è al contrario, che essendo X centro della gravità, ne seguita che BX a XA sia come AX a XD, sì come più chiaramente nella Sua ultima ha mostrato. Sì che a me pare che la dimostratione stia benissimo fondata in quella supposizione la quale si potrebbe forse dimostrare con poca cosa.
Io non mancarò di tener ricordato a Monsignor mio fratello <Francesco Maria dal Monte> quanto Ella desidera. E se son buono a servirLa in altro, mi comandi; e Le bascio le mani. Di Pesaro alli 17 di giugno del 1588.
Di V.S.
Ser.re Guidobaldo
de' Marchesi del Monte

Guidobaldo's appointment as *Visitatore* of the Tuscan castles

In 1588, the dal Monte family was honoured manifoldly by the Medici court: Guidobaldo was appointed *Visitatore* of several Tuscan castles, and his son Orazio

[1] Cf. BNCF, ms Gal. 88, fol. 18r. The letter is published in Galileo, *Opere*, vol. X.

was made "Governatore" of the castle at Pisa, as well as *Generale dell'Arme dello Stato di Pisa*. With the following letter, Guidobaldo expressed his gratitude to Grand Duke Ferdinando I "for the many and many favours You continuously do to my house":[1]

> Ser.mo Sig.r e P.rone mio col.mo,
> Agl'infiniti obblighi ch'io devo all'Alt.za V. Ser.ma per tanti e tanti favori che Ella fa del continuo alla casa mia, non so per ora in che modo mostrarLe altro segno dell'infinito desiderio che io tengo di servirLa se non dedicarLe un mio figluolo per Suo servitore, che avendomi fatta tanta gratia di averlo accettato per tale, mi accresce tanto maggiormente l'obligo che io Le debbo avere. Del che La ringratio infinitamente e Le vivo e viverò sempre obbligatissimo e divotissimo servitore, suplicandoLa a comandarmi che me ne faria gratia singularissima. Et con ogni umiltà Le bascio le mani. Di Pesaro alli 17 di giugno del 1588.
> Di V.A. Ser.ma
> divotiss.o et obligat.mo ser.re,
> Guidobaldo
> de' Marchesi del Monte

Yet, there are still some unresolved questions: did Guidobaldo undertake a trip to Tuscany already in 1588, as BOP, ms 758 claims, or only in 158, the year from which we have several documents regarding his trip?[2] And which were the other of the "many and many favours" received by the Grand Duke? One of it was surely the support of Francesco Maria dal Monte's consecration as Cardinal in December 1588.

I.4.3 1589: Guidobaldo between Tuscany and the Marche

The Medici wedding

In the State Archive of Florence, a description of the ceremonies in occasion of the wedding between Grand Duke Francesco I and Christina of Lorraine is conserved.[3] It constitutes a precious testimony of the honours received by the dal Monte family from the Grand Duke:

[1] Cf. ASF, Mediceo del Principato, 798, fol. 795r. The letter is published in F. Menchetti, *Guidobaldo del Monte nel Granducato di Toscana e la scuola roveresca di architettura militare*, in *Guidobaldo del Monte (1545-1607). "Mathematics" e technics from Urbino to Europe*, cit.

[2] And there is a still more radical possibility: Guidobaldo could have made a trip to Tuscany already in 1586: Francesco Paciotti, an important Urbinate military engineer, who accompanies the former on his trip in 1589, had the same task already in 1586: could it be that they were together in Tuscany as early as 1586, for the first time?

[3] Cf. ASF, Guardaroba medicea Diari di etichetta, 1; here quoted pp. 4-13.

[p. 4] Il dì 24 d'Aprile 1589: In lunedì sul alba si scopersero di Livorno galere da ponente, e subito si fece giudizio che fusse come fu in effetto la Ser.ma Gran Duchezza la quale veniva sopra la capitana del Gran Duca detta "la Nera" e seco tre altre galere di S.A. allora comandate dal Sig.r Pierluigi Rossi Amiraglio della religione di S. Stefano et accompagnata da quatro galee di S. S.tà. (...)
Potevano le galere comodamente venir a desinare a Livorno, dove in quella fortezza allora sotto la cura del Sig.r Cava.r Gio. Volterra governatore di Livorno, non era piazza loggia, sala o stanza capace che non fusse piena di tavole riccamente non meno che delicatamente proviste et accomodate. (...) // (...)
Et mentre ch'arrivano in su la piazza di Livorno la truppa di donne et uomini e di robe come meglio si poteva in tumulto tale si andavono da ministri di S.A. accomodando in lettighe, carozze, cavalli e barchetti che per tal [servigio] quivi erano pronti trecento cavalli di respetto e di vettura: quarante carozze nobili e da nole e cento muli da soma e cento barchetti. Tale ch'ancorche fusse il numero delle gente e delle robe infinito tuttavia si levò il tutto et il tutto l'istessa sera si condusse a Pisa. Et anco si fece più che ragionevole recapito della copiosa provisione che si era fatta per la desinata in Livorno. Dove non tardò Sua Alt.a con tutta la gente per lo spacio di due ore.
E venendosene verso Pisa, fu a San Piero in Grado incontrata dal Sig. Orazio de' Marchesi dal Monte Governatore della fortezza e Generale dell'Arme dello Stato di Pisa con nobilissima comitiva. E poco più vicino alla città si fece superba mostra della fanteria e della cavalleria in bell'ordinanza. E poco lontanto della città fu incontrata dal Sig. Comissario e da tutti gli ministri principali e da tutta la nobiltà di quella città all'entrar della quale vide archi triumphali arrichiti di vaghe pitture, acurissimi motti et superbe insegne conforme alla grandezza e studiosa qualità e bellicosa proprietà de' suoi antiquissimi abitatori: e la fortezza in quel tempo fece ordinata e strepitosissima salva e quella sera si // fece per il Lungo Arno una continua Luminaria che nella luna di quel fiume fece mostra molto simile a quella che così famosa si celebra del Canale grande di Venezia. Et a questa si aggiunse una battaglia navale molto ricca di fuochi e lucente d'Arme che riuscì di bellissima vista per essere molto propria a quella gente maritima. (..)
E quivi si cenò la sera e si stette tutto il dì 26.
Il dì 27 si partì di Pisa e si andò a desinare alla Torre di San Romano e la sera al palazzo dell'Ambrogiana (...) il dì 28 si desinò in essa villa e di poi passando Arno alla Nave a Camacone si andò a cena al Poggio dove si trattenne S.A. tutto il dì 29 veggendo le delizie di quella villa e quivi venne a visitarla il Duca di Mantova et il Cardinale di Gioiosa che già erano in Fiorenza.

> Il dì 30 et ultimo d'Aprile 1589. Si partì dal Poggio e (...) doppo che Mad.a Ser.ma ebbe desinato e riposato al quanto se ne venne alla volta di Fiorenza dove per la porta al Prato fece la sua entrata con quel ordine e con quella pompa che portava la grandezza sua e la potenza et prudenza del Ser.mo Gran Duca di Toscana.
>
> (...) [p. 10] Personaggi venuti a onorare[1] le nozze con il numero delle bocche che conducevano et il numero dei piatti che si facevano alle tavole principali. Oltre alla bassa classe che si spesava ne' tinelli o all'osteria.
> Cardinale dal Monte arrivò in Fiorenza alli 14 d'Aprile e si alloggiò nel palazzo di Piazza <della Signoria> contiguo alle camere del Gran Duca e visse alla tavola di S.A.[2] (...)
> Duca e Duchessa di Mantova arrivi orno il dì 17 detto. Alloggiorno ne<l> <Palazzo> Pitti una parte et il restante al Casino. Ne Pitti si facevono 20 piatti et 10 al Casino. Partì il Duca alli 13 e la Duchessa alli 15 di Maggio e si spesorno per tutto lo Stato e se li dette cavalli, muli e lettighe a nostra spesa sino a Bologna.[3]
> (...) [p.13] Ambasciatore del Duca d'Urbino S. Conte Tomaso di Carpigna si alloggiò e spesò da noi in casa del Sig. Antonio Guidi.[4] (...)
> Principe di Massa si alloggiò ne Pitti dalli 16 alli 24 di Luglio servito da pagi.[5] (...)

Although Guidobaldo is not explicitly named among the guests in the list above, we can assume that he was counted as member of the 10 "mouths" among his brother's company. In fact, we know that he found himself at the wedding: he had arrived on April 30th in Florence, just in time. This can be deduced by his wife Felice dal Monte della Rovere's letter to Ercole Sansoni:[6]

> Mag.co mio Amatissimo
> Per sodisfare all'amorevole desiderio che per la vostra si vede, e senz'altro ne sono sicura, vi dico, ch'il S.or Guid'ubaldo arrivò a salvamento a Fiorenza domenica che furno li 27[7] di Aprile, appunto in tempo di veder l'intrata della Granduchessa che si fece quel giorno e sta benissimo, e così il S.or Cardinale <Francesco Maria dal Monte> et Orazio

[1] onorare *ex* governare

[2] *in marg.* Bocche n. 10

[3] *in marg.* Bocche n. 700, piatti 30

[4] *in marg.* Bocche 6, piatti 1

[5] *in marg.* Bocche 16, piatti 3

[6] Cf. BUU, Fondo del Comune, Busta 113, fasc. 2, fol. 60r. This is confirmed also by ms 758, which however, erroneously, quotes the year as 1590.

[7] Felice confounds the date with April 30th, the real date of Cristina di Lorena's entry in Florence (and also Sunday). April 27th, instead, was a Thursday, as A. Cappelli, *Cronologia Cronografia e Calendario Perpetuo*, cit., reveals.

<dal Monte> mio figliuolo che di tutto [noi] sia ringratiato il S.or Iddio.
Di gratia non [vi] pigliate fastidio di spagnoli né d'altro che di Mad.a Lucretia et di voi se ne tiene et terrà sempre quella grata memoria che merita l'amorevolezza Vostra, senz'altro ricordo; mi serà più caro, se vi si può giovare in cosa alcuna che [vi prevaliate ala libera della Casa]; ch'è quanto m'occorre in risposta della vostra et me Vi raccomando insieme con Vostra moglie ala quale fa il medesimo [Cintia] Di Pesaro li 10 di Maggio 1589.
V. Amor.ma
Felice della Rovere
dei Marchesi dal Monte

Another notice on the wedding stems from Guidobaldo personally. On May 5th, he wrote to Giulio Veterani:[1]

Molto mag.co Sig.r mio oss.mo,
Ebbi buona sorte di poter dar subito la lettera di S.A. al Card.le dal Monte, che per la moltitudine della gente io non gli posso parlar, se non rare volte.
Qua poi le cose delle nozze sono belle (essendosi fatta la comedia et il calcio) e sono belle perché son fatte con gran spesa, se ben anche considerata poi la spesa non par che siano di quella bellezza che potrebbono essere.
V.S. mi favorisca di basciare le mani alli S.ri Giordani con dirgli che io non gli sapiò dar niente di conto della comedia, né del recitare perché qua non ne fanno un caso al mondo, anzi par che faccino quanto si p<u>ò, acciò non sia sentita che fin che si recitava ognun parlava.
Per ora non so che altro me Le dar di nuovo e Le bascio le mani, restandoLe servitore. Di Fiorenza alli 5 di maggio del 1589.
Di V.S.
Servitore Guidobaldo dal
Monte

The inspection of the Tuscan fortresses

Felice dal Monte's letter about Guidobaldo's arrival in Florence on April 30th, and with all probability Guidobaldo's letter to Giulio Veterani (May 5th), both of them exposed above, constitute a precious a *terminus a quo* for the Marquis' inspections of the Tuscan fortresses at the Grand Duke's instance. Further elements for a chronological analysis of his trip in Tuscany are given by the letters we will present in the following.

[1] Cf. ASF, Ducato di Urbino, classe I, 237, fol. 556r.

The first notice about the round-trip we have is a letter written by Orazio dal Monte to the Grand Duke's secretary on June 1st that shows that Guidobaldo passed in Pisa at the end of May.[1]

> (...) Ricevei una lettera di V.S. Ill.ma et ho inteso il dissiderio che ha S.A.S. di fare qua degli archibusieri a cavallo (...).
> Comparvero già ier' mattina <a Pisa> a bonissima ora il Signor Guidobaldo <dal Monte> con il Conte Paciotto e quelli altri signori <Donato dell'Antella and other 48 men>[2] et hanno dato una vista a quello detto Paciotto voleva fare in questa fortezza e infatti si è fatto confessare che li pezzi che stanno per guardare il puntone sono scoperti. Se ne andorno a Livorno, e non avevano ordine nessuno ch'io v'andassi, sì che per il meglio elessi a starmene a Pisa (...). A S.A.S. et ancora dirò a V.S. Ill.ma come il solito è di metter le guardie alla marina e che per quanto intendo per ancora non ci è ordine nessuno, e con questo Le bacio le mani restandoLi servitore di cuore e pregando Iddio per ogni suo contento. Di Castello di Pisa il primo di giugno 1589
> Di V.S. molto Ill.ma e Ecc.ma
> Ser.r aff.mo
> Oratio de' Marchesi dal Monte.

Around the 2nd of June, Guidobaldo and company had reached Leghorn, as we know from a letter written by Giovanni da Volterra, castellan of the fortress at Leghorn.[3]

> (...) Qua fu il Signor Donato dell'Antella con il fratello <Guidobaldo> dell'Illustr.mo Cardinale del Monte con altri Signori e (...) di alogiare in castello che per essere tutti servitori di S.A.Ser.ma li ricevetti volentieri e non credo si intende per questi pure <che direzione prendere von la nuova fortezza> avrò caro che V.S. Ill.mo e Rev.mo me ne avrò se piace a S.A.Ser.ma acciò sapia un'altra volte che ho da fare che tutto scrissero a favore segnalatissimo di V.S. et Rev.mo appresso alli molti altri venuti (...).
> <Livorno, 2 giugno 1589 Giovanni da Volterra>

Next, they continued to Grosseto, as a Guidobaldo's letter (Archivio di Stato di Mantova, busta 1117, fol. 496r.) to the Duke of Mantua shows. This letter is

[1] Cf. ASF, Mediceo del Principato, 806, fols. 256r/v. The letter is published in F. Menchetti, *Guidobaldo del Monte nel Granducato di Toscana e la scuola roveresca di architettura militare*, in *Guidobaldo del Monte (1545-1607). "Mathematics" e technics from Urbino to Europe*, cit.

[2] Cf. ms 758 in this regard

[3] Cf. ASF, Mediceo del Principato, 806, fol. 272r. The letter is published in F. Menchetti, *Guidobaldo del Monte nel Granducato di Toscana e la scuola roveresca di architettura militare*, in *Guidobaldo del Monte (1545-1607). "Mathematics" e technics from Urbino to Europe*, cit.

precious, for it testifies equally, that Guidobaldo has worked also for the Duke of Mantua:

> Ser.mo Sig.r e Padron mio Colend.mo
> Mand'a V.A. Ser.ma i dissegni di Casale, uno dei quali è quello che mi lasciò. Gl'altri due ho accomodati con il miglior modo ch'io ho saputo, sopra li quali ho fatto un poco di scrittura assai breve. Ma di due cose supplico V.A. ad avermi per iscusato, l'una della insufficientia, l'altra della tardanza. Che per aver il Granduca voluto ch'io vada a Grosseto et a Livorno a veder quelle fortezze, è stato cagione, ch'io non gli ho mandato più presto, come dovevo et come avevo fatto.
> Poi al mio poco sapere supplirà il rimettermi a miglior giuditio con supplicarLa a voler accettar da me il prontissimo desiderio che ho di servirLa; e non potrò ricever maggior gratia che di esser comandato da V.A. et con numerato fra i suoi devotissimi servidori. E Le fo umil riverenza. Di Fiorenza alli 10 di Giugno del 1589
> Di V.A. Ser.ma
> Divotiss.o S.re Guidobaldo dal Monte

Still unclear is the nature of Guidobaldo's service to the Duke of Mantua: it could have been a question of a non-recurring consultation, also without the Marquis' personal presence in Casale (Monferrato), but it could have been also a relation of service similar to the one between Guidobaldo and the Grand Duke of Florence, with repeated inspections *in loco*.
Another relevant aspect of the letter is that Guidobaldo was in Florence on June 10th. As we have exposed in Guidobaldo's biography, this fact is important when we attend to the question of a possible (first) meeting between the Marquis and Galileo. As results from M. Camerota's *Cronologia galileana*, the Tuscan mathematician was staying in Florence by that time.
Anyway, turning to Guidobaldo's trip in Tuscany, some while after his stay at Florence around June 10th the Marquis continued and completed his inspections at San Martino and Terra del Sole (and maybe elsewhere?), in the vicinity of the confine between the Medici state and the Duchy of Urbino. From there he turned to Pesaro and reported on this last part of his tour to the Grand Duke:[1]

> Ser.mo Sig.r e P.ron mio colendissimo,
> Mand'a V.S. Ser.ma due dissegni, uno di S. Martino, nel quale ho dissegnato il monti di Roncaticcio, di dove si p<u>ò batter la terra. L'altro è della Terra del Sole sopra la quale, credo, che di già averà inteso dal Sig.r Donato e dal Cavalier Martelli, quanto restassemo d'accordo che si dovesse riferire a V.S. Sì che io non La fastidirò con

[1] ASF, Mediceo del Principato, 807, II, fol. 548r. The letter is published in F. Menchetti, *Guidobaldo del Monte nel Granducato di Toscana e la scuola roveresca di architettura militare*, in *Guidobaldo del Monte (1545-1607). "Mathematics" e technics from Urbino to Europe*, cit.

scriverLe a lungo.
La supplico però che mi perdoni, s'io non L'avrò servita bene, secondo che io dovevo et come sarebbe mio desiderio. Con tutto ciò io non potrò ricevere maggior gratia che l'A.V. si degni di comandarmi, come a servitore obbligatissimo, che sarò sempre prontissimo a metter la vita e quant'ho al mondo in Suo servitio, e di tutta la casa Sua. E Le fo umil riverenza. Che Iddio La contenti. Di Pesaro alli 15 di luglio del 1589.
Di V.A. Ser.ma
Divotiss.o et obligatiss. S.re
Guidobaldo dal <Monte>

Guidobaldo architect of S. Maria degli Angeli

BOP, ms 1841 constitutes the Records of a court suit in November-December 1589, filed by the Camaldolese Order against the mason Giovan Antonio Zandrini and his sons, in occasion of the crash-down of the church Santa Maria degli Angeli. From the witnesses-hearing we can deduce that the church or parts of it, in particular a vault, was crashed down, and apparently the court suit had to clarify to whose responsibility this had to be attributed.
Guidobaldo is one of the testimonies and deposes (fols. 242r-251v) that it was he who made the plans and that he had supervised the works – unfortunately we do not know the exact period when these works were executed. In his testimony, the Marchigian mathematician takes side with the masons, affirming that the problem was the foundation onto which he had have to build the walls, since they had been taking up water. The other attestors were Petrus "Perino" Scaviani ("murator" – mason) (fol. 1r), Domenicus Scacciarius (mason) (fol. 57), M.r Johannes Zognus (mason) (fol. 99), Girolamo Ardizi (fol. 133r), Pier Jacopo (*faber*) (fol. 188r) and Giovanni (*faber murarius*) (fol. 221).
The following passage marks the beginning of the court suit, on November 7th:

[fol. 1r] In Cristi nomine amen. Die septima Novembris 1589. Magister Petrus Filius Magistri Dionisii [Scaviani] de Florentiola Murator Pisauri testis inductus productus citatus iuratus et diligenter examinatus super capitulis productis pro parte et ad favorem Reverendi Patris Don Juliani Protarchi ordinis Camaldulensium // syndiciet procuratoris conventus Sanctae Mariae ab Angelis de Pisauro et Domini Alberti Turturii eius procuratoris substituti.
Super et primo[1], quinto et sexto capitulo omittit, obiit quia partim creditur et partim [se referunt] ad instrumentum dixit [milgare] sermone che mastro Batista Paulani prima che cominciasse a far l'arte delle

[1]et primo *in interl.* *ex* primo

fornaci che [passano] [il] strada da [dici] dotto in [nintiorni/vintiorni] attendeva solo a fare l'arte del muratore ma dopo che cominciò a far le fornaci io non l'ho visto a murare // [fol. 2r] ma solo a negotiare sopra il torre delle legne per la fornace et torre fabriche a fare et chiamare altri muratori a murare anco per se medesimo come anco io son stato chiamato da lui a murare massime le collonne per le [trasanne] per le fornaci.

Super septimo dixit: è vero che l'articulato mastro Giovan Antonio [Zandrini] poche volte ha veduto esso testimonio che lui con le sue mani lavorasse mai nella fabrica della Chiesa delli Frati Bianchi che si fa in Pesaro; ma pur quelle poche volte che lui l'ha veduto // alla fabrica stava a vedere et a comandare alli operarii che caminassero et solecitassero alla fabrica ma l'ha veduto anco esser occupato in altri negotii per la città con la canna come fosse a fare delle stime di case pertinente a muratori et l'ha veduto anco attendere alla fabrica della sua casa che ha fatto et previsamente si [veda] che attendeva a fare accomodare corte pietre a un [starpellino] per le sue case che voleva fare un [cornicione] a suo modo.

Super [octavo] disse pur quanto // [fol. 3r] esso testimonio ha veduto detta fabrica di detta Chiesa et convento è stata fabricata et ridotta nel [murdo] che si trovava ora et come si vede fatta dalli figlioli di detto mastro Giovan Antonio quali esso testimone li ha pur buoni et esperti muratori ma anco da garzoni che erano et sono [peroché] esperti, et da buon mercato come un biasio dal prete, di detto mastro Giovan Antonio et un ginero del Sabbatino che non so il suo nome et un altro Simone figliolo del Frate [Asenaro] che poi fu forzato andare alla guerra et anco [lì] ha lavorato // detto Sabbattino che è un buon mastro.

Super nono disse che (...)

It was on the 5th of December 5th that Guidobaldo deposed. Here is the entire transcription of his testimony (fols. 242r-251v):

In Cristi nomine Amen. Die Decima quinta Decembris 1589. Illustrissimus Dominus Guidobaldus ex Marchionibus Monti set Come dignissimus Terrae Montis Birotii testis inductus productus et examinatus per me Potestatem et Notarium[1] infra scriptum ad instantiam [Zandrini] et Pauluci Durantini in causa quam habet cum Reverendis Patribus Camaldulensibus super capitulis suis et interrogatoriis dictorum Reverendorum *** litterarum Multum Magnifici et Excellentis Domini Vicarii Epicopi Pisaurensis.

[Cui] Illustrissimus Dominus medio eius iuramento testis dixit // deposuit prout infra.

[1] Notarium *ex* Nontarium

Super primo capitulo [eidem] Illustrisimo *** ad eius claram intelligentiam dixit che la verità fu et è che quando li Molto Reverendi Padri dell'ordine camaldolese fecero risoluzione di voler erigere in Pesaro il Convento et Chiesa da nominarsi Santa Maria delli Angioli presero per protettore et loro fautore l'Illustrissimo Signor Raniero suo Padre di felice ricordatione et esso Illustrissimo Signor Guidobaldo suo figliolo per esser loro amorevole della religione sudetta et anco per esser esso Illustrissimo Signor Guidobaldo intervenuto in molt'altre fabriche et acciò fossero asistiti // [fol. 243r] all'aviso et sollecitudine che detta fabrica et che esso Illustrissimo Signor Guidobaldo desse il designo di quella come diede et si essequisse il tutto secondo il suo parere.
Super secundo Capitulo eidem ** supra dixit che essi come nel sudetto capitulo si è detto, è stato riferito di tempo in tempo et di mano in mani alli Reverendi Padri et Ministri della Religione sudetta et sebene li pare anco al Reverendissimo Padre Generale et al Reverendo Padre Don Giuliano da Fossombrone.
Super tertio dixit nihil aliud sive nisi ut super.
Super quarto dixit che le pare che detto Reverendo Don Giuliano abbia // inteso tal fatto et le pare che ne abbia ragionato alcune volte con sua Signoria Illustrissima.
Super quinto Capitulo dixit che non si raccorda particolarmente se tutti li Padri che sono stati a Pesaro per tempo ne hanno avutto notitia, ma sapere che quelli padri che hanno maneggiato le cose della fabrica sempre in ogni occasione hanno del continuo fatto capo con l'Illustrissimo Signor Ranieri vivente et di esso Illustrissimo Signor Guidobaldo in [conforme] le cose occorrenti nell'essequire et nel far il disegno.
Super sexto Capitulo che così crede anco n'abbi inteso di mano in mano detti Reverendi Padri et anco il // [fol. 244r] Reverendo Don Giuliano sudetto; et li pare che anch'egli n'abbia ragionato con esso Illustrissimo Signore.
Super septimo dixit che esso Illustrissimo Signore da principio della fabricha che novamente è fatta in questo designo nelli fondamenti vecchi a [preghi] de detti Reverendi Padri sino al mese d'agosto prossimo passato in circa è intervenuto in tal fabrica per opera santa et pia in dare il disegno et ordini sopra tal fabrica a mastro Giovan Antonio [Zandrini] et suoi figlioli et operarii.
Super octavo che di continuo dal principio di detta fabrica come di sopra sino al sudetto tempo esso Ill.mo // Signore è stato a vederla et visitarla et dar ordini di mano in mano et parere secondo che giornalmente bisognava ogni giorno, ogni terzo giorno, et quando bisognava.
Super nono capitulo che esso mastro Giovan Antonio, figlioli et opera-

rii hanno essieguito di mano in mano dal principio sino al fine quanto dal sudetto Illustrissimo signore gli era ordinato et comandato.
Super dicemo dixit nihil aliud sive nisi ut supra deposuit.
Super undecimo capitulo dixit che il luogo dove è affondata la Chiesa fu et è acquastrinoso [non è della massa] et non è terra ferma ma che ha cattivo fondo come si può vedere. // [fol. 245r]
Super duodcimo capitulo dixit sapere che fu discorso con li Reverendi Padri et altri del modo che si aveva da fare la volta della chiesa predetta ma non raccordarsi se fu discorso con il Reverendissimo Padre Generale di quel tempo.
Super decimotertio capitulo che fu finalmente concluso che la volta non si facesse de mattoni in cintello [perché] si dubitava che la muraglia pur esser in cattivo sito non fosse per comportarla.
Super decimoquarto capitulo dixit che non si facesse anco de mattoni in [perno] perché ogni volta che la muraglia da banda alcuna si fosse mossa un punto se sia cadata a // terra perché si vedeva la muraglia aver [pelato].
Super decimoquinto che fu concluso per parere di sua Signoria Illustrissima et dalli Reverendi Padri che erano sopra ciò che si facesse tal volta di [stuora] di canne del paese et con legnami con buon chiodi et caviglie se ben si ricorda.
Super decimosexto capitulo la qual sorte di volta non è sottoposta alli periculi che sariano state sottoposte le volte de' mattoni in [cortello] o piani per li rispetti sudetti.
Super decimoseptimo capitulo et che nella stalla di sua Altezza Serenissima molt'anni sono fu fatta una volta de mattoni piani che apena finita // [fol. 246r] cascò per terra, per esser edifitio grande et non comportava volte di tal sorte et per questo credo fosse fatta dopoi con [stuore] di canna.
Super decimooctavo capitulo dixit che la sala grande di Sua Alt.a Ser.ma nel Palazzo et qualla delli Priori di Pesaro et del Collonello Antenore credo siano per tal rispetto fatte di [stuorate] come detta Chiesa di Santa Maria delli Angioli; pureché si<a>no cose che si possono vedere che si rifferisero all'evidentia delli luogi sudette.
Interrogatus super interrogatoriis partis adversae et primo interrogatus in causa scientiae dixit predicta sua quae supra deposuit quia vidit, audivit presens *** // singulis congrue refferendo de loco et tempore; dixit non recordare nisi sive sopra deposuit in capitulis de contestibus, dixit de se teste et de agentibus dictorum Reverendorum ac de multis aliis de quibus dixit non recordari.
Super tertio interrogatorio eidem Illustrissimo lecto ad eius claram intelligentiam premessis de *** nitionibus iuramenti respondit che l'Illustrissimo Signor Ranieri suo Padre di felice memoria che non in-

tervenne alla detta fabrica come architetto ma come profettore, di quello pregato dalli agenti di detto convento et per opera pia et come amorevole di detta religione.
Super quarto interrogatorio rispondit // [fol. 247] che è vero che la detta fabrica fu principiata da altri, ma che sua Signoria Illustrissima dopoiché si cominciò a refabricare si servì delli fondamenti vecchi et dette il dissegno sopra quelli; et da principio di detta nova fabrica è stata[1] asistenza con il consenso di quelli Reverendi che di ciò avevano cura e saputa loro di mano in mano sino al tempo detto nelli capitoli.
Super quinto interrogatorio Interrogatus rispondit che crede tra detti Reverendi Padri et l'articulato mastro Gio. Antonio Zandrino et mastro Batista Pauluni ci siano capituli et instrumenti ma che non lo sa precisamente perché sua Signoria non se impacciava di queste cose. //
Super sexto Interrogatorio respondit che si rimette alla ragione delle cose che si contengono nell'interrogatorio.
Super septimo interrogatorio respondit similiter ut supra.
Super octavo dixit prout in capitulis deposuit sed nescire nomina eorum qui intervenerunt in predictis de quibus in capitulis neque recordari pr<a>eter illorum de quibus fuit facta mentio in capitulis.
Super non dixit nihil scire et se a detti Padri non fosse piaciuto le cose fatte non averiano permesso che si fosse fabricato et sforniati tanti dinari.
Super decimo non saper altro nelle cose contengono in detto interrogatorio se non che non si deve presumere che // [fol. 247r] quelli agenti di detta fabrica si intricassero senza comissione se bene non gli cognosce più che tanto senon quanto trattavano seco in nome del Convento.
Super undecimo che crede tali persone amesse a tali uffitii dovessero avere autorità comandata de' suoi superiori.
Super duodecimo dixit nihil sive.
Super decimotertio dixit similiter nihil sive.
Super decimoquarto dixit che non crede che l'altezza è molto vana della Chiesa ancorché sia loco basso possa apportar danno di considerazione alle persone e tali Padri Reverendi, perché in Roma et altri luoghi vi sono // delle più ariose et l'estate al gran caldo vi sentiranno commodo et non danno.
Super decimoquinto dixit che la grossezza delli fondamenti della Chiesa si possono vedere come anco la grosezza di sopra terra delle muraglie et che se bene fossero grosse per li peli che ha fatto dette muraglie per quanto crede pervengono dalli fondamenti non senza pericolo si

[1] è stata *bis*

poteva far la volta in piano se bene se li dava sesto straordinario al piano et sebene si fossero messe travi et altre chiavi per esser di grand'altezza et cattivi fondamenti.
Super decimosexto dixit ut supra.
Super decimoseptimo che crede li peli fatti vengano dalla mala qualità // [fol. 249r] delli fondamenti et non [per sé] dalla muraglie perché si vede esser ben fatte et murate che parono de' mattoni et il [risto] della fabrica doveria far peggio se venisse dalla mala qualità delli muri sendo di minor grosezza.
Super decimooctavo interrogatorio dixit che non crede che detti peli siano cagionati dalla mala qualità delli muri ma dalli fondamenti come di sopra
Super decimonono interrogatorio dixit che crede detta chiesa fosse stata più adornata se di soffitto di tavole adornata de' fioroni varii et vaghi collori et oro con più spesa.
Super vigesimo che in tale suffitte crede vi saria andato più di doi milla scudi volendosi fare come si asserisse con // oro et collori varii et seconda anco la vogliono fare.
Super vigesimoprima che le Chiese si fanno secondo li modelli delli architetti et chi piace in un modo et chi un altro et che la Chiesa di Santo Agostino è fatta all'antica a modo tedesco che adesso non s'usa.
Super vigisimosecundo che puol essere cha a padiglione vi vada più spesa per conto delle misure.
Super vigesimotertio dixit che in Pesaro si costuma [vetro] per pieno et secondo li patti et anco di questo si puol sapere di quelli dell'arte che si rimette a quelli.
Super vigesimo quarto che crede che sia di più utilità a far muraglie di sette o otto [teste] al muratore ma andando // [fol. 250r] anco in alto gli è di danno se bene avanza nelle armature.
Super vigisimoquinto dixit che si puole informare et far esperienza della canna di muro di pietra matta quanta calunara va per canna et quanto sia solito pagarsi in Pesaro et quanta pietra vi vada; che non mancano de' quelli che ne daranno giuditio.
Super vigesimosexto interrogatorio dixit che il debito delle volte formate secondo l'architettura non debbono con loro circonferenza passare il semicircolo come fa quella che non passa come quella si pol vedere.
Super vigesimoseptimo che si dovea dimandare alli maestri del arte come in detto interrogatorio per censo delle[1] // misure se intendono.
Super vigentimooctavo dixit nihil sive se non che è vero che nelle volte di canna quando piove si infragidano.

[1] delle *bis*

Super vigesimonono dixit che li muri de le camere come sono quelle grandi et che vi vanno et che vi vanno le volte a cautela non è male nissuno che li muri siano grosse et massime che in quel luogo non manca sito.
Super trigesimo dixit non sapere de' detti muratori abbino fatto ciò di loro capriccio.
Super trigesimoprimo dixit nihil sive.
Super trigesimosecundo dixit che detti mastri et muratori hanno fatto detta volta con ordine di esso Signore // [fol. 251r] et altri di autorità ma se [naronno] la qualità delli capituli o no, questo non sapere ne raccordarsi.
Super trigesimoterzo dixit che [per] essere che le muraglie della stalla di sua Altezza sia di quattro teste e se bene quella della Chiesa articolata erano di otto nondimeno non si pò bene assicurare per rispetto delli fondamenti come di sopra.
Super trigesimoquarto dixit nihil aliud sive nisi ut supra.
Super generalibus dixit non esser parente attinente a detti muratori et che non si serve di loro né si è servito, et che non li è creditore né debitore et che voria vincesse che che ha ragione et aver deposto pur la verità quanto ha deposto et // essersi confessato et comunicato quest'anno.
Super aliis generalibus recte respondit.

Et ego Jacobus q. Johannis Antonii de Remasanguinibus a Santo Vito publicus imperiali auctoritate Notarius et rapresentiarum Potestas Terrae Montis Birotii predictis omnibus et singulis ut supra predictum Illustrissimum Dominum deponitur presens fui et ea quae rogatus scribere scripsi rigore supradictarum litterarum et publice insignum nomenque meum apponi. *** loco signi[1].

As far as Guidobaldo's occupation with administrative questions in 1589 is concerned, we get some information from the following document (BOP, ms 443, fols. 70v-71r):

Che la Chiesa de' Frati Zoccolanti posta nel Monte di Monte Baroccio sia dentro alli termini e confini di Pesaro e nella diocesi di detta città lo mostra il S.r Guidobaldo del Monte per una sua scrittura, et informazione sopra ciò data, sì perché fu consagrata da più vescovi ma il primo luogo fu dato al vescovo di Pesaro, dal quale ahnno avuti gli olii santi, impetrate le confessioni, predicazioni, l'admissorie et esseguiti gli ordini di detto vescovo nella chiesa sudetta, e detta chiesa nelle indulgenze concesseli da pontefici, cominciando da Papa Nicolò,

[1] *ante* signi *adest signum formae crucis*

vien chiamata “della diocesi di Pesaro”, e da Gregorio XIII quando li concesse l’altrare privilegiato et in altre indulgenze approvate sempre dai vescovi di Pesaro. Il che disse anco Sisto V l’anno // 1589 in un breve et in un’indulgenza, sino dall’anno 1296. Pietro Vescovo di Pesaro la chiama diocesi di Pesaro con altre ragioni e dimostrazioni assai buone. Nel Cass.<ett>o Pes.<ar>o car. 50.

I.4.4 The “payrolls” of the Urbinate court from 1586 to 1589

We were able to find the “payrolls” of the Urbinate court from the years 1586-1589.[1] Their structure is clearly hierarchic, not only regarding the assigned grant, but also regarding the order in which the persons are named. Note the denomination as “family”...
The following list stemming from the year 1586 presents us the “who is who” of the Duchy, with the Duke’s cousin Ippolito della Rovere on the first place, followed by Paolo Marii, bishop of Cagli. They are immediately followed by Ranieri dal Monte and Guidobaldo, still before the Duke’s favourite Giulio Cesare Mamiani and the Counts Fabio Landriani and Giulio Tiene. With Francesco Maria dal Monte directly after them, the dal Monte house is the only one to present three members in the Duke’s court and moreover in the first row. It is, thus, not to hazardous to claim the dal Monte family the most influent one of the Duchy of that time.

La spesa della famiglia nel 1586 a 13 di luglio		
	Spesa	Provisione
L’Ill.mo S.r Marchese della Rovere	B 6 sc. 180	–
Mons.r di Cagli <Paolo Marii>	B 6 sc. 370	–
S.r Ranieri	B 3 sc. 84	–
S.r Guid’Ubaldo	B 3 sc. 84	sc. 150
Co. Giuliocesare	B 3 sc. 84	sc. 100
Co. Fabio Landriani	B 3 sc. 84	–
Co. Giulio Thiene	B 3 sc. 84	sc. 600
S.r Franc.o M.a del Monte	B 2 sc. 60	sc. 100
S.r Ottaviano Fragosi	B 3 sc. 84	–
Co. Mutio Beni	B 2 sc. 60	sc. 60
S.r Volpella Auditore	B 2 sc. 60	sc. 213.20
S.r Cartolaro Auditore	B 2 sc. 60	sc. 213.20
S.r Beluccio Auditore	B 2 sc. 60	sc. 213.20

[1] Their collocation is ASF, Ducato di Urbino, Classe III, 23, fol. 431r/v. The payrolls of the following years are not conserved (at least in the archival unit in question. The chronologically next list stems from the year 1600.

La spesa della famiglia nel 1586 a 13 di luglio		
	Spesa	Provisione
S.r Giulio Veterano Seg.rio	B 3 sc. 84	sc. 150
S.r Avocato Fiscale	B 2 sc. 60	sc. 200
S.r Orlandi	[B 2] sc. 60	sc. 170
S.r Federigo Montorio	B 3 [sc. 84]	–
Co. Sempronio	B 2 sc. 60	sc. 100
S.r Carlo Macigni	B 2 sc. 60	sc. 100
Co. Gabrielle Gabrielli	B 2 sc. 60	sc. 100
Cap.o Ventura Brandano	B 2 sc. 60	sc. 150
Cap.o Paolo Gotio	B 2 sc. 60	sc. 100
m.s Almerigo Medico	B 2 sc. 60	sc. 100
Il Colonello Guerra	B 2 sc. 60	sc. 80
Cap.o Giuliano Triangoli	B 2 sc. 60	sc. 80
Cap.o Riccio Orlandi	B 2 sc. 60	sc. 80
Cap.o Ant.o Francesco Vanuccio	B 2 sc. 60	sc. 80
Cap. Marcant.o Schieti	B 2 sc. 60	sc. 80
S.r Lodovico Mamiani	B 2 sc. 60	sc. 60
Co. Francesco M.a Mamiani	B 2 sc. 60	
m.s Alessanrdo Bruniori	B 2 sc. 60	sc. 60
m.s Giulio Giordani	B 2 sc. 60	sc. 72
m.s Felice Paciotto	B 2 sc. 60	sc. 72
Il Caval.re Ardovino	B 2 sc. 60	sc. 60
Il Caval.re Sorbolongo	B 2 sc. 60	sc. 36
Il Caval.re Papirio	B 2 sc. 60	sc. 48
Il Caval.re [Burrecherini]	B 1 sc. 30	sc. 36
Co. Torquato Brancaleoni	B 2 sc. 60	sc. 36
m.s Giovampaolo Ricardi	B 2 sc. 60	sc. 60
m.s Fabio Braglioni	B 2 sc. 60	sc. 60
Co. Germanico Ubaldini	B 1 sc. 30	sc. 36
m.s Benedetto Passonei	B 1 sc. 30	sc. 36
m.s Giulio Brandano	B 1 sc. 30	sc. 36
Il Signorotto	B 2 sc. 60	sc. 36
m.s Teodosio Petrucci	B 1 sc. 30	sc. 36
m.s Lutio Musetti	B 1 sc. 30	sc. 36
m.s Rafaelle Gualtieri	B 1 sc. 30	sc. 36
ms. Antonio Nanni	B 2 sc. 60	sc. 56
ms. Francesco Sottom.o di Casa	B 1 sc. 30	sc. 50
m.s Severo Mang.o Thesoriere	B 2 sc. 60	sc. 60
m.s Vinc.o Reved.re	B 1 sc. 30	sc. 60
m.s Giovani Ant.o Reved.re	B 1 sc. 30	sc. 36
<Somma [fine della prima colonna]>	B 120 sc. 3442	sc. 4352

La spesa della famiglia nel 1586 a 13 di luglio		
	Spesa	Provisione
Il Cancelliere dell'entrate	B 1 sc. 30	sc. 65
m.s Guid'Ubaldo Rafaelli	B 1 sc. 30	sc. 36
m.s Stefano Grani sal.ba	B 2 sc. 60	sc. 48
m.s Aniballe Zucca	B 1 sc. 30	sc. 48
m.s Giulio Pace sottoscalco	B 1 sc. 30	sc. 36
m.s Diotalene Ricci Sottoscalco	B 1 sc. 30	sc. 36
c.s Calisto Furieso	B 1 sc. 30	sc. 36
m.s Oratio del S.r Veterano	B 1 sc. 30	
Paggi	B 6 sc. 180	-
Servitori loro	B 2 sc. 48	sc. 12
M.ro delli paggi	B 2 sc. 60	sc. 50
Doi capellari	B 3 sc. 84	sc. 32
Do' Venturino	[B 1 sc. 30]	[sc. 32]
m.s Sinibaldo [Sperale]	B 1 sc. 30	sc. 50
m.s Antonio Borganuci	B 1 sc. 30	sc. 36
***	B 1 sc. 30	sc. 24
Barbiero	B 1 sc. 30	sc. 36
Tre aiutanti di camera	B 3 sc. 50	sc. 108
Dispensieri	B 2 sc. 54	sc. 42
Speditori	B 2 sc. 54	sc. 30
Credenzieri	B 3 sc. 78	sc. 78
Bottighieri	B 2 sc. 54	sc. 54
Cuochi	B 5 sc. 138	sc. 116
M.ro Bezivello	B 2 sc. 60	sc. 48
Portieri	B 2 sc. 60	sc. 48
Stafari	B 8 sc. 192	sc. 96
Lazzaro aiuto di camera	B 1 sc. 24	sc. 12
Oratio al gioco della palla	B 1 sc. 30	sc. 12
Orologgiero	B 1 sc. 30	sc. 60
m.o Ottaviano al'armaria	B 1 sc. 30	sc. 30
Sarti doi	B 2 sc. 54	sc. 48
Tapezzero	B 1 sc. 30	sc. 24
Marescalchi	B 2 sc. 60	sc. 36
Cocchieri	B 2 sc. 60	sc. 48
Pasarino	B 1 sc. 30	sc. 24
Baccalaro	B 1 sc. 24	sc. 12
Trombetto	B 1 sc. 30	sc. 36
Corriero	B 1 sc. 24	sc. 24

La spesa della famiglia nel 1586 a 13 di luglio		
	Spesa	Provisione
Bracarolo	B 1 sc. 30	sc. 15
Struzzero	B 1 sc. 30	sc. 15
Uccelatore	B 1 sc. 30	sc. 30
Giardinero di Pesaro	B 1 sc. 24	sc. 12
Giardinero del'Imperiale	B 2 sc. 36	sc. 24
Giardinero dela poss.ne della fonte	-	sc. 8
Spaccazocchio	B 1 sc. 24	sc. 8
Pagliaiolo	B 1 sc. 24	sc. 12
Acquaroli	B 2 sc. 48	sc. 16
Spazzi	B 2 sc. 48	sc. 16
Canovari di Pesaro	B 3 sc. 84	sc. 50
Lavandara della famiglia	B 1 sc. 20	sc. 24
Lavandara di S.A.S.	B 1 sc. 20	sc. 8
<Somma seconda collonna>	B 88 sc. 2416	sc. 1845
Mulatieri [fol.430r]	B 7 sc. 168	sc. 56
Garzoni delli cocchieri	B 2 sc. 48	sc. 16
Il [Polo già] al tinello	B 1 sc. 30	
Fornaro	B 1 sc. 30	
Scoltore	B 2 sc. 60	
Miniatore	B 2 sc. 60	
Oreffice	B 2 sc. 60	
Orologgiero Todesco	B 1 sc. 30	
Gio. Jacomo Lavora d'ebbano	B 1 sc. 30	
Genuagio Legalibri	B 1 sc. 30	
Antonio Visaccio Pittore	B 1 sc. 30	
Giovanni Nano	B 1 sc. 20	
Muto	B 1 sc. 30	
Famegli della stalla	B 16 sc. 384	z. 128
<somma terza colonna>	B 20 sc. 1040	208
<somma prima colonna>	B 110 sc. 3442	4352
<somma seconda colonna>	B 88 sc. 2410	sc. 1845
<somma totale>	B 238 sc. 6898	sc. 6397
E più i sottoscritti salariati d'Urbino		
Fattore d'Urbino		sc. 50
Guardarobba		sc. 50
Canovaro		sc. 48
m.s [Ligie] Vinciolini		sc. 30

La spesa della famiglia nel 1586 a 13 di luglio		
	Spesa	Provisione
Muratore		sc. 42
Ufficiale della Paglia		sc. 24
<somma>		sc. 284
E più la spesa de' svizzeri compreso il vestir et ogn'altra cosa importa da		sc. 2700
E più la guardia de' soldati		sc. 1000

Essentially the same situation is shown by the payroll of 1587 (ASF, Ducato di Urbino, Classe III, 23, fol. 443r/v). This time, we find listed also Giuliano della Rovere, Ippolito's brother and so another Duke's cousin. Note that Ranieri does not appear anymore, as he passed away in January 1587, whereas Guidobaldo held his outstanding position, as also Francesco Maria dal Monte.[1]

A dì XII di Giugno MDLXXXVII In Pesaro. Lista della Famiglia di S.A.S. che si ritrova di presente.	
	Spesa
L'Ill.mo S.or Marchese della Rovere	B 6
L'Ill.mo Mons.r Giuliano della Rovere	B 3
Mons.r di Cagli	B 6
S.or Guidubaldo del Monte	B 3 sc. 150
Co. Fabio Landriani	B 3
Co. Giulio Thiene	B 3 sc. 600
S.or Federigo Montorio	B 3
Co. Oratio di Carpegna	B 3
Co. Gabrielle Gabrielli	B 2 sc. 100
Co. Sempronio Malatesta	B 2 sc. 100
S.or Carlo Macigni	B 2 sc. 100
S.or Volpella Auditore	B 2 sc. 213 1/3
S.or Cartolaro Auditore	B 2 sc. 213 1/3
S.or Bellucci Auditore	B 2 sc. 213 1/3
S.or Avocato Fiscale	B 2 sc. 200
S.or Veterano Seg.rio	B 3 sc. 150
M.s Giulio Giordano	B 2 sc. 72
Cavaglier Sorbolongo	B 2 sc. 72
M.s Oratio alla Secretaria	B 1 sc. 30
S. Con. Giulio Ces.re Mamiani	B 3 sc. 100

[1]This time we do not report the entire list, only the most important entries for our purposes.

A dì XII di Giugno MDLXXXVII In Pesaro. Lista della Famiglia di S.A.S. che si ritrova di presente.	
	Spesa
S.r Franc.o M.a del Monte	B 2 sc. 100
.....	
Caval. Ardovino	B 2 sc. 60
M.s Giovanni Scultore	B 2
M.ro Pietro Orologgieri	B 1 sc. 60
Orologgier Todesco	B 1
Iacomo che lavora l'ebbano	B 1
.....	
M.ro Lazaro alla Fonte	B 1
Il Muratore	B 1
<Somma>	B 252 sc. 6645
	Le Bocche sono n.ro 252

Here is the payroll of the year 1588 (ASF, Ducato di Urbino, Classe III, 23, fol. 444 r/v). Again, this list give us an idea about Guidobaldo's importance in the courtly ambiance and so in the Duchy: after the Duke's cousins, he is the first named member of the court. His brother Francesco Maria does not appear anymore – we are ignorant of the causes, since at this time, the relation between Francesco Maria II della Rovere and Francesco Maria dal Monte must have been still excellent. But note that no son of Guidobaldo's is listed (while, e.g., Giulio Cesare Mamiani's son Francesco Maria seems to have already been part of the court, despite of his birth in 1579). In contrast, Orazio dal Monte entered at the Grand Duke of Tuscany's service in 1588: first as *Governatore* of the Castle at Pisa, then as Grand Duchess' donzel. This suggest a certain orientation of Guidobaldo, the family head, versus the Grand Duchy of Tuscany.

A dì 8 Agosto 1588 in S. Leo	
L'Ill.mo S.r Marchese dalla Rovere	B 6
Mons.r Giuliano dalla Rovere	B 3
S.r Guidobaldo dal Monte	B 3 sc. 150
Co. Giuliocesare Mamiani	B 3 sc. 100
Co. Francesco Maria suo figliuolo	B 2
Co. Fabio Landriani	B 3
Co. Giulio Thiene	B 3 sc. 600
Co. Oratio di Carpegna	B 3
Co. Sempronio <Malatesta>	B 2 sc. 100
Co. Carlo Macigni	B 2 sc. 100

A dì 8 Agosto 1588 in S. Leo	
S.or Zuchella Auditore	B 2 sc. 213 20
S.or Bellucci Auditore	B 2 sc. 213 20
S.or Sinibaldo Auditore	B 2 sc. 213 20
S.or Avocato Fiscale	B 2 sc. 200
S.or Veterano Seg.rio	B 3 sc. 150
M.s Giulio Giordano	B 2 sc. 72
.....	
Caval. Ardovino	B 2 sc. 60
M.s Giovanni Scultore	B 2
M.ro Pietro Orologgieri	B 1 sc. 60
Orologgier Todesco	B 1
Iacomo che lavora l'ebbano	B 1
.....	

Again, the situation seems unchanged in the payroll of July 1589, with Guidobaldo again in the first row (and his brother reappeared) (ASF, Ducato di Urbino, Classe III, 23, fol. 445r/v). This is significant in the context of the deterioration of the relations between Guidobaldo (and the dal Monte family in general) on one side and the Duke of Urbino on the other (cf. Appendix I, I.5). This fact suggests that the fact that Guidobaldo entered in the Grand Duke of Tuscany's service was not the (only?) reason for the dramatical pejoration of their relations.

A dì 8 di Luglio 1589 in Pesaro	
L'Ill.mo S.r Marchese dalla Rovere	B 6
Mons.r dalla Rovere	B 3
S.r Guidobaldo del Monte	B 3 sc. 150
Co. Giuliocesare Mamiani	B 3 sc. 100
Co. Francesco Maria suo figluolo	B 2
Co. Fabio Landriani	B 3
Co. Oratio di Carpegna	B 3
Co. Thomasso di Carpegna	B 3
Co. Sempronio	B 2 sc. 100
S.r Francesco M.a del Monte	B 2 sc. 100
Cap.o Francesco Ferretti	B 3 sc. 250
Co. Carlo Macigni	B 2 sc. 100
S.or Zuchella Auditore	B 2 sc. 213 20
S.or Bellucci Auditore	B 2 sc. 213 20
S.or Sinibaldo Auditore	B 2 sc. 213 20
S.or Avocato Fiscale	B 2 sc. 200
S.or Veterano Seg.rio	B 3 sc. 150

A dì 8 di Luglio 1589 in Pesaro	
S.r Perrozzi	B 3 sc. 200
M.s Giulio Giordano	B 2 sc. 72
.....	

A sharp contrast is presented, instead, by the chronologically next payroll that has survived (at least in the archival unit in question: ASF, Ducato di Urbino, Classe III, 23; the payroll of 1600 is collocated at fol. 446r/v): Guidobaldo does not appear anymore, nor anybody of his family. This is in accordance with what will be exposed in Appendix I, I.5.

A dì 16 di Febraro 1600 in Pesaro	
L'Ill.mo S.r Marchese della Rovere	B 6
Mons.r Ill.mo della Rovere	B 3
L'Ill.re S.r Conte di S. Agnolo	B 3 200
S.r Co. Francesco Maria Mamiani	B 2
S.r Agnolo Mamiani	B 2
S.r Giulio Giordano Seg.rio	B 3 sc. 200
Co. Brancaleone	B 2 sc. 100
Co. Sempronio Malatesta	B 2 sc. 100
Co. Carlo Ubaldini	B 2 sc. 100
Cap.o Silla Baregnano	B 2 sc. 100
.....	

Equally, neither in the payroll of 1606 Guidobaldo compares.[1] Only in the year 1608,[2] a "S.or di Monte Baroccio" is listed, surely Francesco Maria dal Monte (II), Guidobaldo's first born son, and in the meantime nominated Marquis of Monte Baroccio, at the second page: this suggests that he did not belong to the most important members of the court.

A dì primo maggio 1608			
	Bocche	Prov.ne	Vitto
Conte di Sant'Angelo	3	100 [scudi]	200.45
Il Belluzzi Aud.re e Con.ro	2	213.20	
detto per signature e patente		186.40	
Il Minio Aud.re e Con.ro	2	213.20	
detto per signature e patente		186.40	

[1] Cf. ASF, Ducato di Urbino, Classe III, 23, fols. 497r-501r; we do not report the list in question.

[2] ASF, Ducato di Urbino, Classe III, 23, fols. 503r-507r.

A dì primo maggio 1608			
	Bocche	Prov.ne	Vitto
Il Veterano Aud.re e Con.ro	2	213.20	
detto per signature e patente		186.40	
Consiglieri sei	12	1800	
Abbate Brunetti Seg.rio	3	200	200.45
Il Basilio Seg.rio	2	150	146
Il Fatio Seg.rio	2	100	127.45
Conte Francesco Maria Mamiani	2	100	
Conte Lelio Arivabeni	3	620	
Conte Sempronio Malatesta	2		
Il Giordano	2	100	146
Il Ricardo	2	100	146
Il Paciotto	2	100	146
Cap. Silla Barignano	2	100	146
Cap. Claudio Cerboli	2	100	146
// Il Salandro	2	100	146
Sig.r di Monte Baroccio	2	100	146
L'Eurispa	2	100	146
Conte Carlo Ubaldini	2	100	146
Il Bettino	2	100	146
Conte Agnolo Mamiani	2	60	
Conte Ottavio Mamiani	2		
Il Cavalca Cam.ro	2	60	
Il Castaldo Cam.ro	2	60	
Il Medico Colle	3	500	
Il Medico Moco	2	100	127.45
Capitano Pompeo Bandini	2	80	127.45
.....			

I.5 The deteriorating relation between Guidobaldo and Duke Francesco Maria II

Few is know about the cause(s), the trigger and all the stages of the process that led to the dramatical deterioration of the relation between Guidobaldo and Francesco Maria II, which was excellent still in the eighties. Nevertheless, we will try to highlight in the present section the main elements that constituted this progress and will so shed some light on this mysterious element of Guidobaldo's life.

As we will document in Appendix II, I.3, the first tension between the Dal Monte family and the Duke of Urbino arose by Francesco Maria II's disinterest to become bishop of Pesaro, despite of the Duke's personal offer. The preserved letters show the Francesco Maria II's serious annoyance about this fact. Yet, with the combined effort made by Ranieri, Francesco Maria and most probably also Guidobaldo they succeeded in placating the Duke. But in 1587 Ranieri, the originator and guarantor for the outstanding role of the Dal Monte family, died. This might be considered one of the crucial elements. Not only for the fact, that a subject whose loyalty for the Dukes of Urbino over several decades was undoubted, as a stabilizing element, had passed away. But Guidobaldo had to care now for all the responsibilities relative to his task as Count of Monte Baroccio, apart from all the other duties he had. Surely he had consequently even less time to spend in the Duke's vicinity. This might seem a relatively irrelevant argument. But when we consider the intrigues at the court and the envy that there was surely towards the important and influent Dal Monte family, it might reveal a fundamental factor. Francesco Maria dal Monte himself once talked about persons that "do not love our house".[1]

A turning point was constituted by the year 1589, that much is clear. Guidobaldo had accepted to enter in the Grand Duke of Tuscany's service as military architect, like his son Orazio had done one year before. And Francesco Maria dal Monte, with his disinterest versus the episcopate of Pesaro in 1586 and his decision, instead, to stay in the vicinity of the Cardinal de' Medici, exactly Ferdinando I, Grand Duke of Tuscany from 1587 on, had done a similar thing.[2]

Now, it was not unusual that subjects of the Duchy of Urbino worked for other sovereigns, in particular also for the Grand Dukes of Tuscany: like Aurelio and Ottaviano Fregoso, Francesco Paciotto and others without falling in the Duke's disgrace. The reasons in Guidobaldo's case, yet, might have been more psychological: Francesco Maria II is often characterised as a rather difficult and suspicious person. So the "change of side" by three members of the former most important

[1] Cf. BOP, ms 1534, fasc. 33, fol. 2r; the question is about the letter written to Alessandro Barignani on the 18th of November 1600, cf. its transcription bellow.

[2] Other Guidobaldo's relatives had done similarly, like Ottaviano Fregoso.

family of the Duchy in only four years could have been too much for the Duke – considering also the fact, that Guidobaldo and Francesco Maria dal Monte were the Duke's intimates from childhood on – maybe he had expected more loyalty exactly from them. This hypothesis is confirmed by some sources that describe Francesco Maria II's "enormous jealousy" when Guidobaldo had entered in the Grand Duke of Tuscany's service.[1] It is, though, countered by the fact that Guidobaldo still appears in the courtly payroll of 1589 (cf. Appendix I, I.4.4), i.e. *after* Guidobaldo's departure from Pesaro to Tuscany. In this context, it is advisable to keep in mind that the relations between the Duchy of Urbino and the Grandduchy of Tuscany traditionally were not always the best ones.

So on one hand, the situation in June 1589 – Guidobaldo had already gone in Tuscany – does not yet seem precipitated.[2] Yet, then on September 20th, Guidobaldo complained with Giulio Veterani that he had not got the money he deserved in base of his wife Felice della Rovere's marriage portion. Was it a coincidence that Guidobaldo raised the complaint exactly at that moment? As we will see below, this affair had a long story of over 15 years.[3] Had happened something that provoked Guidobaldo's act of defiance?

There could have been, though, another trigger for the deterioration of the relations, this time by Francesco Maria dal Monte's fault: after the story of the episcopate of Pesaro in 1586, Guidobaldo's brother seems to have provoked other incidents that caused the Duke's annoyance, as the following document evidences: Cardinal d'Este composed in 1599 a report about Pope Clement VIII's court and comes so *inter alia* to speak also about Francesco Maria Cardinal dal Monte.[4]

> Fran.co Maria Car.le del Monte
> Fu cortegiano già di Sforza il vecchio, e per una sua maniera affabile e graziosa entrò talmente in gratia al Car.le di Medici che fatto Gran Duca l'impetrò il Capp.o che lasciava. E' di Marchesi del Monte S.ta Maria che si fanno della Casa Borbona; e ne portano l'insegna; era conf.<identissi>mo del Duca d'Urbino del quale portava l'armi inquartate, ma dopo che si concesse al Gran Duca non troppo confidente

[1] Cf. BOP, 1009, ("Abecedario degli architetti e pittori pesaresi" di D. Bonamini), pp. 60/61: "Nell'anno 1588 <Guidobaldo> ebbe commissione dal Gran Duca di Toscana che gli aveva fatto far cardinale il // fratello Francesco Maria del Monte, di visitare tutte le fortezze dello stato e questa fu la cagione della fierissima gelosia colla quale lo vide poi Francesco Maria II suo Signore, scacciandolo dalla corte assieme col primogenito di Guidubaldo." See Appendix I, II.4.

[2] The courtly payroll of 1589 was composed on the 8th of June: Guidobaldo appears, like the three years before, practically at the top of the list, also as far as his income is concerned, cf. Appendix I, I.4.4

[3] Cf. Ranieri dal Monte's letter from July 3rd 1572.

[4] Cf. ASF, Carte Strozziane, prima serie, 226, fol. 156r/v.

> d.[o] Urbino diede tal disgusto a questo Principe massimamente quando levò delle sue l'armi della Rovere che non bastò l'interessamento di m.[ti] Car.li a riconciliarlo seco.

So, this document testifies the Duke's great annoyance caused by Francesco Maria's laying down of the della Rovere-arms (which was constituted, *inter alia*, by the della Rovere-oak). Yet, we do still be ignorant if this procedure was a spontaneous action (in connection with Francesco Maria's relation to the Tuscan court) or rather a reaction to the maltreatment towards Guidobaldo.

Yet, besides the search of (a?) possible reason(s) for the deterioration of the relations, the year 1589 can anyway be determined as a turning point: apparently, Guidobaldo has seldom stayed at Pesaro from this year on, when we consider the places from where Guidobaldo sent his letters.[1] Let us have a look these places regarding all his letters written from 1580 until his death, with the respective recipient in brackets:[2]

Dates (and recipient)	Place
January 4th 1580 (Giacomo Contarini)	Pesaro
February 15th 1580 (Giacomo Contarini)	Pesaro
October 9th 1580 (Giacomo Contarini)	Pesaro
November 14th 1580 (Filippo Pigafetta)	Pesaro
December 18th 1580 (Giacomo Contarini)	Pesaro
December 31st 1580 (Filippo Pigafetta)	Pesaro
January 21st 1581 (Filippo Pigafetta)	Pesaro
February 24th 1581 (Filippo Pigafetta)	Pesaro
March 5th 1581 (Filippo Pigafetta)	Pesaro
April 2nd 1581 (Filippo Pigafetta)	Pesaro
April 24th 1581 (Filippo Pigafetta)	Pesaro
April 29th 1581 (Filippo Pigafetta)	Pesaro
May 2nd 1581 (Filippo Pigafetta)	Pesaro
May 21st 1581 (Filippo Pigafetta)	Pesaro
September 1st 1583 (Count Tommasi)	Pesaro
August 12th 1587 (Giulio Veterani)	Pesaro
January 16th 1588 (Galileo)	Pesaro
March 24th 1588 (Galileo)	Pesaro

[1] This seems nearly the only instrument to comprehend where he dwelt at the respective moments when he wrote the letters: in Pesaro, in the impressive city residence in the Duke's closest neighborhood, or in Monte Baroccio, far from the courtly life and the Duke.

[2] We will not count the letters written to Guidobaldo, although they would be a further confirmation for our hypothesis: but they do not often contain any precise information where Guidobaldo was staying. And when they do contain it, it is not said that the sender, especially if he lived far away from the Duchy (as Francesco Barozzi, e.g.), had a precise information about Guidobaldo's sojourn. So they are a unreliable instrument.

Dates (and recipient)	Place
May 28th 1588 (Galileo)	Pesaro
June 17th 1588 (Ferdinando I, Galileo)	Pesaro
July 13th 1588 (Clavius)	Pesaro
July 22nd 1588 (Galileo)	Pesaro
August 10th 1588 (Pier Matteo Giordani)	Monte Baroccio
September 16th 1588 (Galileo)	Pesaro
October 7th 1588 (Galileo)	Pesaro
December 8th 1588 (F. Bonaventura)	Pesaro
December 23rd 1588 (Ferdinando I)	Pesaro
December 30th 1588 (Galileo)	Pesaro
May 5th 1589 (Giulio Veterani)	Firenze
June 10th 1589 (Vincenzo I Gonzaga)	Firenze
July 15th 1589 (Ferdinando I)	Pesaro
August 3rd 1589 (Galileo)	Monte Baroccio
September 20th 1589 (Giulio Veterani)	Monte Baroccio
April 10th 1590 (Galileo)	Monte Baroccio
June 16th 1590 (S. Vincenzo)	Monte Baroccio
July 20th 1590 (Clavius)	Monte Baroccio
December 8th 1590 (Galileo)	Monte Baroccio
October 21st 1591 (Giulio Veterani)	Monte Baroccio
December 6th 1591 (Giulio Veterani)	Monte Baroccio
January 12th 1592 (Giulio Veterani)	Monte Baroccio
February 8th 1592 (Giulio Veterani)	Monte Baroccio
February 17th 1592 (Giulio Veterani)	Monte Baroccio
February 21st 1592 (Galileo)	Monte Baroccio
September 3rd 1592 (Pier Matteo Giordani)	Monte Baroccio
January 10th 1593 (Galileo)	Monte Baroccio
September 3rd 1593 (Galileo)	Monte Baroccio
September 30th 1597 (Confalonieri di Fano)	Pesaro
December 17th 1597 (Galileo)	Pesaro
July 28th 1598 (Clavius)	Pesaro
May 1st 1599 (Francesco Maria II)	Pesaro
May 10th 1599 (Pier Matteo Giordani)	Pesaro
September 21st 1599 (Pier Matteo Giordani)	Badia
December 12th 1599 (Clavius)	Pesaro
August 5th 1600 (Muzio Oddi)	Pesaro
July 3rd 1601 (Muzio Oddi)	Pesaro
September 6th 1601 (Antonio Guerranti)	Pesaro
June 1st 1602 (Marcello Accolti)	Monte Baroccio
September 2nd 1602 (Marcello Accolti)	Monte Baroccio
August 20th 1603 (Clavius)	Monte Baroccio

Dates (and recipient)	Place
January 1st 1604 (Pier Matteo Giordani)	Monte Baroccio
November 23rd 1604 (Pier Matteo Giordani)	Monte Baroccio
December 6th 1604 (Pier Matteo Giordani)	Monte Baroccio
December 31st 1604 (Pier Matteo Giordani)	Monte Baroccio
January 20th 1605 (Pier Matteo Giordani)	Monte Baroccio
January 21st 1605 (Pier Matteo Giordani)	Monte Baroccio

Obviously, the precedent table give us only approximate informations about Guidobaldo's sojourns, given the ample spaces of time between certain letters.[1] Yet, it reflects in an impressively way what we have delineated in Guidobaldo's biography: in the eighties (and before) he was in the Duke's service, and therefore almost always in Pesaro,[2], while it is not preserved a single document, that shows him in Pesaro from September 1589 until September 1597. And also his return to Pesaro, documented by the letters from September 1597 until September 1601, does not mean that he was reintegrated in the court: the payroll of 1600 does not show any trace of Guidobaldo or any other members of the dal Monte family.

So, conclusively, we consider the hypothesis very probable that the problems between Guidobaldo and the Duke began in summer 1589. Probably not prior to Guidobaldo's return to Pesaro, but presumably connected with his service for the Grand Duke, possibly also with Francesco Maria's behaviour after the nomination as cardinal. Maybe the Marquis was not prudent enough to calm the situation after his return to Pesaro – after all, he did not occupy with diplomatics, as in contrast did his father Ranieri – and possibly, instead, he has made claims regarding the marriage portion of his wife, the Duke's half sister.
Thereupon, in the following years one conflict alternated the next one, despite of Guidobaldo's attempts to regain the Duke's favour. The sad peak of this development was the exilement to his feud Monte Baroccio from 1602 to 1605.
In the successive subsections we will delineate the stages of the process of the deterioration of the relations between Guidobaldo and the Duke.

I.5.1 Felice dal Monte's marriage portion

Felice dal Monte, wife of Guidobaldo from the years around 1560, was one of the illegitimate daughters of Duke Guidobaldo II (and *eo ipso* Francesco Maria II's half sister). The payout of her marriage portion was by no means a recent point

[1] For example, no single letter written by Guidobaldo in the periods between 1583 and 1587, or 1593 and 1597 seems conserved.

[2] Of course, the Duke was not always in Pesaro, but also in Urbino and Casteldurante. But as we have shown, Guidobaldo had to execute various duties for the Duke in Pesaro, also when the Duke was not present.

of conflict. Based on the content of BOP, ms 453 (cf. below) and the information furnished by the other documents reported in the following, we can partly reconstruct the problem:
Guidobaldo, despite of the honour received by the Duke in offering him his daughter for the Marquis' wife, had not got immediately the promised marriage portion – in fact, the financial problems of the Duchy under Guidobaldo II are well-known. Some years after, Duke Guidobaldo II disposed that he should obtain yearly 500 *scudi* of gold, as interest of the outstanding payment of the marriage portion, as long as the entire portion was not paid. This worked after a fashion as Ranieri's letter from 1572 shows. Then, around 1588-89, Duke Francesco Maria II seemed to have intended to partly clear the debt. Guidobaldo complained in a letter to Giulio Veterani, in 1589, that he needed also the rest of the sum. Moreover, as BOP, ms 443, fol. 447v testifies, a conflict arouse about the question if the sum of the marriage portion had to be interpreted as *scudi* of gold or normal *scudi* – apparently a huge difference. It is not clear, who of the two parties tried to damnify the other: was is Guidobaldo who pretended too much money, or was it the Duke who did not want to pay Guidobaldo what the latter deserved in base of the marriage contract, concluded by Duke Guidobaldo II and Ranieri dal Monte. A lawsuit in 1592, with the Duke's *Auditori*[1] as judges, cleared this question to Guidobaldo's disadvantage, not surprisingly. Yet, in 1606 the lawsuit was rolled up again, as BOP, ms 453 documents. The purpose of the action, this time filed against Guidobaldo, seems to have been the declaration that also the interest had to be intended as an amount of ordinary *scudi* and not of gold.

Already in 1572, Ranieri dal Monte had complained to Guidobaldo II that his son had not received the interest of the marriage portion. The tone of the letter subsequently reported is remarkable, probably only few subjects in the Duchy could permit themselves to approach the Duke with a similar determination.[2]

> Ill.mo et Ecc.mo S.re e P.ron mio sing.mo,
> sono molt'anni che V.Ecc. Ill.ma si degnò dar per moglie la S.ra Felice a Guid'Ubaldo mio figliuolo, né, per molt'anni che sieno passati, gl'è stato mai fatto assegnamento alcuno di dote. E' ben vero che poc'anni sono, V. Ecc. Ill.ma si compiaccque che da Ugobbio gle ne fusse pagato il frutto. Nel pagamento del quale, per il poco conto che ne hanno fatto, i suoi ministri mi hanno [destratiato] sempre, come sanno i suoi segretari e tacendo io questo per minor fastidio di Lei.
> Ultimamente essendo stati un anno che non mi hanno pagato, si son

[1]The "*Auditori*" were a special kind of judges, cf. Appendix II, I.1, "Badoer's relation of 1547".

[2]Cf. ASF, Ducato di Urbino, I, 259, fol. 147r. In fact, in the chronologically next letter (not reported here), conserved equally in ASF, Ducato di Urbino, I, 259, Ranieri apologises for his tone.

coperti col dire che ne sia stato causa l'assignamento del S.r Prencipe Ecc.mo et che per questo, per me, non ci sia stato modo alcuno da pagarmi; cosa che è falsissima perché l'assignamento del S.r Prencipe fu fatto circa quattr'anni sono e a me hanno satisfatto sempre eccetto quest'anno passato: et i ministri di quel tempo fanno fede che vi è modo da pagar il passato et il presente. Et se sia il vero o no, V. Ecc. Ill.mo lo considera da questo con la prudenza Sua, che l'assignamento di M.s Giovanni, che è stato d'assai dopo il mio, e pochi dì fanno quello del Cap. Valerio. Tutti sono stati pagati et io sono il patiente. Se si deve andar per chi sia anterior nell'assignamento, a me par che mi sia fatto torto. Et se'l si va per servitù, sa solo V. Ecc. Ill.ma se in me sia de' merito o no. Et si degni considerare che questi sono frutti di dote e non meriti di servitù. Tal che il tormi questo è un torre a me per dar ad altri.

Tutti questi errori mi vien detto che son causati al tempo del buon Girol. Il quale non può negare che non sii stato pregato di remedio, da me e le più volte da miei ministri, et sempre se ne è riso, facendone poco conto compiacendosi del mio pregiudizio, come sa m.s Giulio <Veterani> che ne ha avuto per mia cagione spesso molestia.

Non restarò anco di dirLe, premendomi il caso come fa che il buon Pietro Pauolo Ondedei ha voluto ancor lui dar delle commissioni a suo modo, et valersi di questo assegnamento come gl'è parso. Se bene gli son stati mandati danari da Ugobbio, ad effetto che gli desse a me, et ne ha fatto il parer suo.

Ora se questi tali sono incorsi in error alcuno a me par che ne doverebbono riportar [gastigio/gastigho]. Et se questo gl'è stato commesso da altri, supplico V. Ecc. Ill.ma che si degni con la prudenza Sua dar qualche remedio a questo: non comportando che per commission d'altri mi sia tolto il mio.

Altro non ho che dirLe: et umilmente Gli baso la mano, pregando il S.r Dio che Le doni quanto La desidera. Di Pesaro 3 di luglio 1572.

Di V.Ill.ma Ecc.za

Umil. E fid.mo ser.re

Ranieri dei mar.si del Monte

In September 1589, Ranieri had passed away in the meantime, the question arose again. The following letter (BOP, ms 426, fol. 161r/v) is a clue for the friction that had developed between Guidobaldo and the Urbinate court. Presumably, it is not a coincidence that Guidobaldo approached Giulio Veterani, the last representative of the Guidobaldo II's regime – Veterani had served as secretary already under Francesco Maria II's father – who had been in excellent relations with Ranieri dal Monte.

Molto magnifico Signor mio osservandissimo,
mi è forza di replicar a V.S. a mostrarLe chiaramente come dalli ministri di S.A. si son fatti li conti degl'usufrutti della dote, e perché V.S. sia informata, adesso fa quasi l'anno, cioè quando il signor Duca tornò a Pesaro io feci istanza con il Beccoli più volte che si facessero questi conti, et al fine commise a messer Vincenzo Pierpauli che li vedesse, il quale rimuscinò per parecchi giorni et settimane tutt'i libri della cancellaria, e per quello che podde trovare formò un conto di sua mano, il qual mi son risoluto di mandarlo in mano di V.S. acciò veda la verità. La prego bene di volermelo rimandare, et vedendo che S.A. restava debitore all'ingrosso di D. 2500, volse vedere i libri di casa mia nei quali trovò molte partite che non erano nei libri della camera.
Oltre di questo volse il Beccoli che si guardasse nei libri di Ugubbio per veder se poteva trovar maggior lume, et così diede la commissione al medesimo messer Vincenzo che quando andava per riveder i conti di Gubbio volesse guardar nei libri anche per questi conti. Il qual messer Vincenzo doppo Pasqua andò a Gubbio et guardò et non trovò cos'alcuna in contrario di quanto gli fu mostrato da noi.
Ora due cose mi fanno esser molesto a V.S., l'una il contratto acceso che come prudentissima so che considera che la cosa non sta bene così, l'altra è che io ho da dar al capitano Federigo Bianchino per conto di quella possessione che io comprai da lui e mi trovo molto intrigato perché // speravo di poterlo satisfar intieramente con li dinari della dote che mi erano stati promessi tutti, ora vorrei potermi valer almanco di questi.
Non sarò più lungo, La prego a favorirmi e mi rimandi il conto che Le mando, come se ne sarà servito. E mi comandi che desidero di servirLa, e Le bascio le mani. Di Monte Baroccio alli 20 di settembre del 1589.
Di V.S. servitore affettuosissimo,
Guidobaldo dal Monte.

Apparently, Guidobaldo's appeal to Giulio Veterani did not had the desired effects. In fact, the Catalogue of the ducal writings ("*Repertorio degli Scritti ducali*" BOP, ms 443 fol. 447v, reports about the lawsuit between Guidobaldo and the Duke's chamber we have mentioned above, and summarizes its (for Guidobaldo) negative outcome in 1592:

> Aveva mosso giudizio la Sig.ra Felice moglie del Sig.r Guidobaldo del Monte contro il fisco e Camera del Sig.r Duca d'Urbino dimandando che li scudi promessi per la sua dote di moneta venessero dichiarati doversi intendere scudi d'oro e non di moneta. Dalla quale pretensione fu absoluto il fisco dalli Uditori giudici deputati, rogato m.s Guido-

baldo Guidarelli da Cagli Cancelliero Ducale il dì 9 febbraro 1592. Nel cass<etti>no Pesaro car. 80.

The lawsuit was reopened in 1606:[1]

Informatione in fatto nella causa dei frutti della dote dell'Ill.ma S.ra Felice con il fisco del Ser.mo:
Il Ser.mo Sig.r Duca Guidobaldo di felice memoria promise all'Ill.mo S.r Guidobaldo dal Monte scudi diecimila per dote dell'Ill.ma S.ra Felice et insinoché la sudetta quantità fosse pagata costituì et assignò al S.r Guidobaldo un annuo reddito de' scudi cinquecento de' grossi 23 sopra l'entrata di Gubbio per frutti della sudetta dote. Dopo la morte del S.r Duca Guidobaldo, il Ser.mo nostro Sig.re <Francesco Maria II> volendosi liberar da una parte del sudetto peso, ordinò che si pagassero al S.r Guidobaldo cinquemila scudi per parte della sudetta dote. Alora nacque differenza si li scudi della dote fossero de' grossi 23 l'uno com'erano i frutti. Tal difficoltà fu commessa alli Ecc.mi Ss.ri Auditori da decidere.
Et intanto dalli Ss.ri Ministri di S.A.S. furono numerati al S.r Guidobaldo scudi cinquemila di sorte principale con la confessione de' tutti i frutti sino a detto tempo come appare per un instrumento a car. 17 che così sotto buona fede fece il S.r Guidobaldo per sodisfatione del S.r Beccoli alora maestro del entrata di S.A.S. quale promise, fatto il conto, che l'avrebbe sodisfatto, come per una copia d'una lettera del detto S.r Beccoli in questo a car. 21 appare.
Li Ss.ri Auditori sententiorno: Dotem scutorum currentium constitutam, non esse auctam ad scutos aureos, com'a car.33, poiché non c'era disposizione particolare del S.r Duca Guidobaldo che dichiarasse tal augumento nella sorte principale come è manifesto et chiaro che i f<rutti> fossero de' grossi 23 l'uno, com'appare dall'allegationi qui annesse. // Ora si dubita se la sentenza delli Ss.ri Auditori la quale parla solamente della sorte principale, s'estenda alli frutti già più di 40 anni in sin oggi riscossi et consumati a buona fede a ragione de' grossi 23. Et dall'allegationi si possono vedere le ragioni a favore del S.r Guidobaldo con risposta ancora dell'oppositioni principali del fisco del Ser.mo. //

Adsit Deus.

Haec sunt consideranda ad favorem Ill.mi Domini Guidi Ubaldi a Monte contra fiscum Ser.mi <Ducis> in illo iuris articulo an sententia lata in sorte extendatur ad fructus, de quibus nulla in ea sit facta mentio.

[1]Cf. BOP, ms 453, fols. 164r-167r.

Et primo supponitur et pro ratione principali adducitur, quod concessio facta a Ser.mo D<ucis> Guido Ubaldo <II> fel.<icis> record.<iae> scutorum aureorum quingentorum de grossis 23 pro quolibet scuto super redditu Eugubii pro [interv.nio] dotis Ill.mae D. Felicis, sit valida. Cum sit fulcita p.o auctoritate monumentorum Francesci Orlandi, ut fol. 6 quod quidem plene probat per ea quae tradit Bar. in ** nuda ratio sub n.o 7 ** de dona quem refert, et sequitur Bald. in rub. (de consti. pecu. sub n.o 14)
Secundum. Auctoritate epistolae Ser.mi D.<ucis> nostri eiusdem manu subscriptae, ut fol X quae probat ut per dictum latem in l. 1 ff. de consti. princi. Et in l.2 (de leg.). It[em] possent dici verba enunciativa, tamen disponunt; Quin quando Princeps aliquid concedit motu proprio et huic assertioni initatur eius intentio, tunc enim huiusmodi verba probant, cum hoc casu ita videatur asserere tanquam instructus de [facti ventate]. Latiss.e Mascar de proba alios plures allegans conclu. 621 sub n.o 2. Praesertim quando assereret factum sui genitoris, etenim praesumitur quod instructus ita asseruerit. [Idem] Mascar. d. conclu. 521 n.o 9 compluribus per eundem citatis:
Terzum. Auctoriate duorum instrumentorum ut fol. 13 1[2] 16 in quibus [lt] enunciati[*] sit facta mentio de praedicto annuo redditu; lattame favore dotis verba enunciativa inducunt plenam probationem Castr. Cons. 92 n.o 2 lib.2 per tex in l.2 com glos. "De dotis promiss." immo et dispositive, ut in illis patet fol 12, 15.
Quartum. Auctoritate librorum [r<ati>onum] Ser.mi et Ill.mi in quibus hanc inde ennaratur dictur aureus redditus ad r<ati>onem trossorum 23 ut in illis patet[1] qui plene probant per ea quae tradit late Mascar. De proba et ter vel quater fuer[unt] factae quietationes ad dictam rationem ut mihi supponitur, et probatori per isntur. Ut fol. 13 et ad praedicta facit id quod dixit Bl. In l. fin n.o 9 "Sine cens." Vel reliq. Approbatus a fel. In c. ad audientiam sub n.o 16 de praescrip. Ubi asserit, quod si per libros [petuales] apparet, quo dita consuetum est per decem annos; non est aliud inquisendum[2].
Quintum. Auctoritate legis cum de in rem verso * de usu. Ubi ex diuturna praestatione usurarum dotis praesumitur contracta obligatio super usuri set super sorte et quatenus est necesse ad illam praestationem redigendam importat praestandi necessitatem [sm] Bar. [quem/qui/..] approbant omnes etiam in leg. si centis annis "De pact. ubi Ias dec. Et alii abb cons. 74 in princ. Lib.1 Balb. De praesin par. prima, 3a par. 9, 10, 20 et segg. //

.....

[1] *signo posito in marg.* ut in lib. 1564 fol 32 et lib. 1565 fol 130 et sic fol. 31, 22 et 27, 28.
[2] et ad praedicta ∼ aliud inquisendum *diversa manu*

Annibal Almericus Ad.<voca>tus Ex praedictis Excell.mi Auditores Domini Francescus Belutius, Aemilius Aemilius, Stefanus Minius declara[runt] fructus exactos ac bonafide consumptos et in posterum exigendos uscque ad integras solutionem 5000 scutorum currentium sortis [presentis] fuisse et [eodem] rite et [recte] exactos ad rationem gross. 23 ** quolibet scuto et in posterum ad praedictum rationem ** exigendos: Et sic declaratio fuit ad favorem Ill.mi et ** fiscum Ser.mi lata sub die 26 Aprilis 1606. Sub rogitu D<omini> Jacobi [Zettae] Canc. Ducali [Audientis].

I.5.2 The planned marriage between the families dal Monte and Mamiani

From autumn 1591 on, we have several documents that testify Guidobaldo's efforts to establish a tie between the families dal Monte and Mamiani, the former the most influential in the past, the latter the most important at that time, marriage. The involved members are not known to us, but from a letter written by A. Barignani we come to know that a male dal Monte offspring was planned to marry a female member of the Mamiani family.
The beginning of a series of letters about the marriage is constituted by the following missive written by Guidobaldo to Giulio Veterani on October 21st of 1591:[1]

Illustrissimo signore mio osservandissimo,
Mi è dolut'assai che questa venuta giù del Signor Federigo <dal Monte> questa seconda volta, sia stata così mal intesa, che se noi avessimo saputo che S.A. Serenissima ne avese potuto aver tanto disgusto, La p<u>ò esser certa che non l'averessimo mandato, essendo nostra principal intentione di ricuperar la gratia di S.A. e di far questo parentado per amor del conte Giulio Cesare <Mamiani> con ogni satisfattione, come ho scritto al signor Cardinale <Francesco Maria> dal Monte e dategli conto di quanto è passato et anche dettegli l'opinion nostra che saria di saper se'l Serenissimo Signor Duca si contenta, che con sua buona gratia si facci questo parentado, essendo noi obligati di saper la volontà sua prima di ogni altra cosa e poi anche di rimetter in S.A. ogni cosa. Mi è parso bene che V.S. sappia quanto si è fatto da noi.
Staremo aspettando la risposta del signor Cardinale e le bascio le mani. Di Monte Baroccio alli 21 di ottobre del 1591.
Di V.S. aff.mo servitore,
Guidobaldo dal Monte.

[1] Cf. BOP, ms. 426, fol. 167r.

Presumably, "the Sir Federigo's arrival down the second time", cited in the letter above, refers to what Federigo dal Monte wrote to Giulio Veterani in the following letter:[1]

> Molto Ill.re S.r mio oss.mo,
> Ho ricevuto la sua amorevolissima et la confidanza che tiene in me [per] questo negotio, ne sii pur sicurissimo, come lo conoscerà, in tutto quello che potrò non si può negare che non vi vengono de' disturbi, pur spero in Dio che abbi aver bon fine. Il S. Piermatteo <Giordani> L'informarà del tutto et Li bascio le mani pregandoLa mi comandi.
> Di Monte Baroccio li dì ottobre[2] '91.
> Di V.S. Ill.re
> Ser.re Aff.mo Federigo
> dal Monte

As the next letter shows, Guidobaldo involved many of his friends in the negotiations. This is not only deducible from the fact that he announces the arrival of several "Sirs" to Giulio Veterani:[3]

> Ill. Sig.r mio oss.mo
> V.S. sa quant'io ho stimato sempre i Suoi consigli, sì come intenderà da questi Sig.ri, che per non esser lungo io non starò a scrivere quanto sia passato tra noi, li quali molto meglio referiranno di quello che saprei scriver io: riportandomi adunque a quanto essi diranno non La fastidirò più con questa mia, ed offerendomeLe per servitore, Le bascio le mani. Di Monte Baroccio alli 6 di decembre del 1591.
> Di V.S.I.
> Aff.mo s.re Guidobaldo
> dal Monte

In fact, from a letter written by Alessandro Barignani to his brother Silla, two parents of Guidobaldo's, we can deduce that Alessandro participated as well in the negotiations (cf. Appendix I, I.5.4, BOP, ms 425, fols. 139r-140v, November 1st 1602). He tells there to have been "sent many and many times to negotiate about Count of S. Agnolo's daughter's marriage". This gives us an idea of the frequency of the meetings.
Moreover, obviously also Pier Matteo Giordani and the Cardinal dal Monte were involved, besides the already cited Federigo dal Monte and Giulio Veterani, and not to mention obviously Count Giulio Cesare Mamiani and the Duke of Urbino. This can be deduce from the successive letter (BOP, ms. 426, fol. 173r/v) written by Guidobaldo to Veterani:

[1] Cf. BOP, ms 412, fol. 62r.
[2] *ante* ottobre *om. dies*
[3] Cf. BCS, Autografi Porri, vol. IV, lettera 121, fol. 169r.

Ill.mo Sig.r mio oss.mo,
La lettera di V.S., insieme con molte altre cose dette a tutti noi, ci han apportato quel contento ch'Ella si p<u>ò immaginare, vedendo tanta buona volontà che mostra S.A. Ser.ma verso di noi et il desiderio che tiene che si esequisca questo parentado. La veda che siamo arivati ormai a quel segno tanto da noi desiderato della gratia di S.A. Vorrei stendermi in lungo sopra questo, ma so che V.S. intende benissimo quanto potrei dire.
Circa poi la buona volonta del S.r Conte di S. Angelo <Giulio Cesare Mamiani>, di questo io ne son più che certo. Piaccia a Dio che io sia da tanto di mostrar il contracambio dell'animo di tutti noi et il desiderio che tutti abbiamo di servirlo. Resta mo' che si tratti con il S.r Cardinale <Francesco Maria dal Monte>, il qual spero che non sarà renitente.
Quanto poi a noi non resta altro se non che V.S. ci favorisca di procurar in tutt'i modi che lo sposalitio non s'abbi da far prima che a questo autunno che viene, perché prima ci tornaria tanto e tanto scomodo che V.S. non se lo potria immaginare, l'aver noi questo duolo così fresco, e di consideratione, potria esser causa che con giusta ragione, si differisse il scoprirlo questo parentado finché S.A. volesse andar a Urbino, con intentione che come torni // si abbi da effettuar ogni cosa. Ma di quest'e d'altre cose ancora mi riporto a quanto Le dira il S.r Piermatteo <Giordani>, che per non fastirLa Le bascio le mani.
Di Monte Baroccio alli 8 di febraro del 1592.
Di V.S.
Aff.mo serv.re, Guidobaldo
dal Monte

Remarkable is the intervention even by Simone Fortuna, Cardinal della Rovere's former secretary and connected in the meantime with the Medicean court. On the one hand, given his former service to Giulio della Rovere, he surely was in good relations with the Urbinate court. On the other hand, he has equally certainly been involved by the Cardinal dal Monte, who on his side was one of the most influential members of the Medici court. Here is Fortuna's letter to Giulio Giordani from April 25th 1592, the "favour done to the Marquis dal Monte" probably refers exactly to the marriage:[1]

Ill.re et m.to ecc.te mio amor.mo Sig.ria,
Con estremo condoglio mio intesi la perdita che al S.or Dio è piaciuto che facciamo del S.or Giulio <Veterani> nostro di onorata et felice memoria. Et posso veramente dir di restar privo del maggiore et più caro et antico amico et Sig.re ch'io avessi in questo fallacissimo mondo

[1] Cf. BOP, ms 1605, folios not numbered.

(...). La ringratio ancora di quanto ha operato a favor delo Marchese <Guidobaldo> dal Monte al quale feci mandar le Sue lettere.
Noi qua siamo in gran [facende] per il battesimo che si deve far del Principe et Principessa nostri. Comparve mercredì il S. Duca di Mantova con bella compagnia il quale lo tiene a nome dell'Imperatore. Prima era venuto il S. [Duca Virg.] con la moglie. Ieri venne il Car.le Sforza (...)
Di Fiorenza li 25 d'aprile 1592

Yet, we are not in cognition of the outcome of the marriage negotiations – this is connected to the problem that we know nearly anything about Guidobaldo's sons and brothers. In the spring of 1592, Giulio Veterani died, so it is not clear that the negotiations came to a good end, given that he was the important link between Guidobaldo and the Duke, who was not so favourable about the marriage.

I.5.3 Another conflict in 1597

The situation did not calm with the years, as we learn from the following letter written by the Cardinal dal Monte probably to Belissario Vinta, anyway to the office of the Medici court: Francesco Maria dal Monte reports that Guidobaldo had regained the Duke's grace – which automatically means that Guidobaldo had fallen in disgrace another time, precedent to this letter. And this vicissitude in question does not seem to be connected with the marriage negotiations in 1591-92, for Guidobaldo had then regained the Duke's grace, as he himself writes to Veterani of February 8th 1592 (cf. above). Yet, the Cardinal complained about the way, in which the Duke had behaved, "as if <Guidobaldo> had committed some grave delict".
Unfortunately, the attached letter Francesco Maria talks about, it not preserved, it would have maybe cleared the circumstances of this persistent conflict between Guidobaldo and the Duke. Yet, it is anyway a precious document that testifies the Duke's repeated harassments Guidobaldo was exposed to – and the intervention with which Francesco Maria dal Monte tried to help his brother from Rome:[1]

Molto Ill.re S.re,
Per l'inclusa del <Giulio> Giordano, il Duca d'Urbino ha reintegrato nella gratia sua mio fratello. Veda V.S. con che mezzo et come se avesse comesso qualche grave delitto. Io l'ho caro acciò possi vivere quieto et potrà più facilmente servire il Granduca.
Se Le occorre cosa veruna di quei paesi, piaccia a V.S. di darne conto a S.A.S in mio nome; et di rimandarmi la lettera del Giordano non avendo altro aviso che il suo. Et con questo di core La saluto. Di Roma l'ultimo di Gennaro del 1597.

[1] Cf. ASF, Mediceo del Principato, 3760, fol. 517r.

Di V.S. molto Ill.e
Come fratello Amor.mo
Il Card.le dal Monte

The next letter shows, that Francesco Maria had also contacted the Duke personally regarding this affair. It tells us moreover that Guidobaldo's sons, as well, had been included in the Duke's disgrace:[1]

Ser.mo S.r et P.ron mio oss.mo
Cosa non potevo sentire di maggior consolatione che l'intendere che V.A.S. abbia reintegrato nella Sua gratia mio fratello con i suoi figluoli [!]. Et sì come spero che con la loro servitù (conforme agl'infiniti oblighi che Le teniamo) procureranno ogni giorno di accrescere questa Sua buona volontà, io ancora in ogni occasione procurerò l'istesso a più mio potere.
In questo mentre con ogni umiltà rengratiandoLa Le prego dal S.re il compimento d'ogni Suo desiderio, et Le bacio le mani. Di Roma il primo di febraro del 1597.
D. V.A. Ser.ma
Devotiss.o et Obl.mo Ser.re
Il Card.le dal Monte

I.5.4 The exilement in 1602

The deteriorating tendency of the relations between Guidobaldo and the Duke culminated in 1602, when Guidobaldo as well as the Duke's cousins Ippolito and Giuliano were exiled. A summary is given by Domenico Bonamini who writes in this regard in the "Cronica della Città di Pesaro":[2]

Mi è ignoto per quale cagionen il Duca Francesco Maria II licenziasse il M.se Ippolito della Rovere suo cugino (ed in questo tempo anche suocero giacché il Duca avea in moglie D. Livia, figlia del detto Marchese), come anche il M.se Guid'Ubaldo del Monte tanto dotto e famoso matematico così stretto al Duca di parentela per essere marito d'una naturale del defunto Guid'Ubaldo II. Non bastò questo che anzi furono licenziati dalla corte e mandati in esiglio. V'è chi lasciò scritto che ai 26 d'agosto di quest'istesso anno insieme col Sig.r Luigi Orlandi fossero ambedue presi e posti in Rocca, lo che spesso allora acadeva, essendo Francesco Maria di sua natura assai inclinato a conculcare la nobiltà per avere l'auge del popolo, e dell'infima plebe.
Scrisse il Zaconi <altro storico locale> nelle Miscellanee che ai 28

[1] Cf. ASF, Ducato di Urbino, I, 107, fol. 17r.
[2] Cf. BOP, ms 966, pp. 160/161.

maggio 1604 fu richiamato dalla fortezza di S. Leo il M.se Ippolito della Rovere ed il Sig.r Ab. Giuliano suo fratello.

A summary of the vicissitudes in question is comprised in the letter written by Tommaso Count of Carpegna to the grand-ducal office in Florence:[1]

> Molt'Ill.r Sig.re mio sempre oss.mo
> Sono stato a Urbino, ho detto esser stato costà, il perché et il [come], com'anche la gratia che S.A. mi ha fatto del locho di paggio del gran maestro per mio figliolo.
> Entrai poi a render testimonio al S.re Duca della bona voluntà che Le porta il Granduca, et quanto sicuramente può promettersi l'aiuto suo in tutte l'occasioni avend'io detto in questa parte quel più ho giudicato approposito perché il S.r Duca ne restasse bene accertato, mostrandole che con quello il Granduca professa di bona voluntà verso l'A.S. si accorda anche il suo interesse, dovenendole veder più volentieri quello stato in mano di un Prencipe che della Chiesa. Mostrò il S.r Duca gustare assai di questa referenza dicendo ne stava sicura ma che tutto ciò le piaceva il novo testimonio che ne rendevo et passò meco in questo lungo ragionamento et parmi che questa volta meglio che mai abbia ricevuto quest'ufitio.
> Feci poi con il Conte Giulio Cesare un bon ragionamento in simil propositio, mostrandole che il Granduca aveva molto ben notitia della persona sua (...).
> E l'affari de SS.ri della Rovere caminano a malissima strada nel vero per lor difetto, poiché avendo nel principio del disgusto a<v>uto occasione di riunirsi con ogni sodisfatione et onore, non hanno saputo farlo [et] risposto a lettere amorevoli di S.A. con più asprezza che non conveniva in modo che hanno sdegniato il S.re Duca di maniera che ultimamente cercavano loro di tornare et far delle sumessioni che prima non erano richieste et non hanno trovato passaggio. Et mentre io ero a Urbino furono presi due gentilomini pesaresi, uno di Casa Farnetis, l'altro Orlandi aderenti de' suddetti SS.ri, et incappucciati l'uno fu condotto nella Rocca di San Leo et l'altro di Sinigaglia; così anche il vennere prossimo passato pur in Pesero fu preso un M.s Terentio agente di Mons.re della Rovere et messo in Rocca, et oggi mi [fu] scritto che domenica notte il Marchese et Mons.re con la più parte delle robbe che poterono levare partirono da San Lorenzo lor castello, non sapendosi per dove ancorché si giudichi per Roma.
> L'actioni [!] di questi SS.ri son oggi intese male da tutto lo stato, et quanto da prima erano compatiti, tanto son oggi biasimati, et certo che non hanno mostrato prudentia né conosciuto il lor servitio. Si può

[1] Cf. ASF, Mediceo del Principato, 911, fol. 14r/v.

credere sarà ora difficilissimo si riunischino più con questo Prencipe, et io da questa lor partita impetuosa vado giudicando che li carcerati suddetti possino saper forsi qualche particolare che temino venghi a notitia di S.A.
Intano è arivato in Urbino il S.r Lelio della Rovere nipote al già Card.le di questo nome, dicano di passaggio, ma facilmente il S.re Duca lo fermerà alla corte per pesar in lui i pensieri che doveva avere a benefitio de suddetti SS.ri
Con molta più prudentia l'ha passata il S.re Guido Baldo del Monte il quale ritiratosi al suo castello se n'è stato quietamente senza mostrar senso sì che oggi il S.re Duca ne resta ben sodisfatto.
Per non fare una lunga [cifera] ho voluto mandar il presente <u>omo mio et con recordami a V.S. servitore obbligatissimo Le bascio le mani facendo il medesimo mia moglie alla S.ra [Comare] et Sig.ra Sposa. N. S. conceda Loro ogni felicità. Di Scavolino li 4 settembre 1602
Di V.S. M. Ill.re
Obl.mo Comp.re et cert.mo Serv.re
Tomasso di Carpegna

The following letter by Alessandro Barignani to his brother Captain Silla, already mentioned in the subsection above, is a meaningful and alarming document of how Guidobaldo was, at least after the exilement, isolated also from his last friends and relatives:[1]

Ill.re S.r fratello oss.mo
Con quanto mio dispiacere e travaglio io abbi sentito quello che mi scrivete c'ha passato il Sig.r Duca Ser.mo intorno alla persona mia, non posso esprimere né con questa lettera né con mille ch'io ne scrivessi perché è pur gran cosa ch'io non ho mai pensato né studiato in altro che di vivere in modo et dirizzare tutte le mie attioni in maniera che potessi aportar bene la mente e gusti si S.A. e non ho mai potuto o saputo arrivarci e so che tutta la colpa e mancamento è dalla parte mia ma ch'io abbi [maniato] mai in cose che possino riguardare la fede et ostenianza ch'io son tenuto di mostrare in tutte l'occasioni questo son ben sicurissimo e certissimo che non si trovarà mai; né crederei che qualche negligenza o inavvertenza mia dovesse mai essere tirata in questo senso.
E per venire al fatto presente, se la lettera che si pretende che sia scritta a me da Monsig.re Fortuna è pur sua come pare che si affermi, sono anco sicurissimo che non si potria mai da quella raccogliere ch'io mi sia mostrato nei negotii delli Sig.ri della Rovere di affetto diverso da quello ch'io son tenuto a mostrare negli interessi del mio Padrone

[1] Cf. BOP, ms 425, fols. 139r-140v; November 1st 1602.

perché sempre che mi è occorso di scrivere et al Fortuna et a chi si sia altri, ho scritto veramente e sinceramente tutto quello che sentivo che sempre è stato che quelli Sig.ri dovessero dare ogni sodisfattione a S.A. e se si sono vedute le lettere scritte altre volte dal med. Fortuna in questo particolare (com'io credo che debbano essere state vedute molt'altre volte) si sarà anco veduto ch'egli gli dava il torto e ha replicato più volte che dell'opinione mia che devessero accomodarsi alla voluntà del Sig.r Duca. Erano anco il Granduca e il Card.le del Monte e però le medesime lettere del Fortuna dovevano aver chiarito questo punto se sono state vedute come posso credere dal successo di questa e in questo particolare non so come si possi giustificare per la parte mia se non con negare il fatto perché veramente non è vero ch'io abbi trattato nel modo che si presupone. Se bene è verissimo ch'io ho scritto alcune lettere poche volte ch non arrivano a quattro sinceramente a quelli Sig.ri con li quali non solamente ho creduto di poter trattare senz'ombra di disgustare S.A. Ser.ma ma quelli Sig.ri me n'assicurarono con [presuppormi] che il S.r Duca non gli aveva privati della gratia sua et che n'avevano sue lettere et che tenevano il negotio per accomodato e questa fu non solo opinione loro ma di tutta la corte e di tutti quelli c'avevano notitia di questo negotio e non è cosa da potersi negare per verità di modo che non so perché l'attioni mie debbano essere giudicate dai [fatti] e dalli successi delle cose e non più presto dall'intentione e dalli accidenti che correvano nel tempo ch'io trattai.

Ch'io abbi trattato col S.r Card.le del Monte qualche cosa per mio servitio è verissimo e non voglio negarlo e questo fu dopo la parita di S.A. da Pesaro perché avendo sentito dal S.r Belluzzi il senso che mostrava il Sig. Duca contra me e sapendo la purità della mia conscienza e l'innocenza mia nelle cose che mi venivano opposte dubitai di non avere persone appresso S.A. che facessero de' mli offitii contra me e quello che più importa me n'assicurai e sapete che ne s<i>ete stato certificato voi ancora da persone che lo potevano sapere. Und'io per levarmi di tutti questi pericoli e per sincerare tanto maggiormente l'A.S. procurai di levarmi di Pesaro e però pregai al S.r Card.le del Monte che volesse favorirmi di procurarmi qualche trattenimento in Roma ma con persone amiche et aderenti del S.r Duca che secundo la speranza che me n'avesse dato io poi avrei trattato della buona gratia di S.A. per partirmi. Et prima che sia stato negotiato nessuna cosa per me per essere stato il S.r Card.le a Fiorenza e succeduta la partita delli Sig.ri della Rovere per Roma et io per levare ogni sorte di ombra a S.A. scrissi al Fortuna non sapendo se il Card.le del Monte fosse in Fiorenza che in ogni modo facesse offitio con S.S. Ill.ma che non pigliasse altra fatica per me perché ero molto ben risoluto di non volere

più trattenimento in Roma e di questo pregai al Fortuna con molta instanza; e questa deve essere la risposta che dinota che passasse negotio importante tra noi e se quest'offitio è degno di biasimo o di pena io mi rimetto. La lettera venuta sotto coperta del Sig.r Piermatteo non so come possi essere stato, senon fosse che avendo scritto al detto Monsig.re che stavo per partire per Padova non assicurandosi egli che mi fosse per trovare in Pesaro abbi inviato la lettera sotto coperta al Sig.r Piermatteo perché non è molto ch'io ricercai al Fortuna che mi mandasse certa foglietta di rame per servitio del S.r Piermatteo ch'era mio cugino et non sapendo egli a chi inviare la lettera gli venisse in mente il S.r Permatteo e si risolvesse di mandarla sotto la sua coperta.
Quanto alla strettezza con li Sig.ri del Monte io non trattai mai né andai mai a Monte Baroccio se non quando ci fui mandato tante e tante volte per trattare del parentado della figlia del Conte di S. Agnolo e in questo non credei né pensai mai di disgustare l'A.S. e il medesimo averia creduto ogniuno per mio parere.
Se per rimediare dunque a tanti pericoli che soprastanno non ho da fare altro che lasciare d'ingerirmi nelle cose delli Sig.ri della Rovere e del Sig.re Guidobaldo questo è già fatto e stabilita e ne sia tanto lontano come se non gli avessi mai conosciuti e il medesimo farò in qualunque cosa ch'io possi conoscere che sia di gusto e sodisfattione dell'A.S. non essendo tanto ** di me e privo di giuditio che non conosca quello che mi si conviene e per debito di fede e d'osservanza e di avere, ma bisogna ricordarsi che il mio male non nasce da queste radici perché prima che siano succedute le cose della quali si tratta, adesso dovete ricordarci quello che vi disse di me S.A. quando ci andaste per le cose degli Emilii; e io mi ricordo anco benissimo quello che mi disse per parte sua il Cotne di S.Agnolo e il Belluzzi si ché questa è un hidra che non può essere recisa di tanti capi, che continuamente intergono contra me con cos' poca cosa com'è questa che mi si avertisce.
Mi sarà però necessario di sapere se in questo numero delli Sig.ri dal Monte ci venga compreso il Sig.re Giovanni Battista e ch'io sappi come ho da trattare con lui stando qua et essendo molto favorito da lui che non saria perciò così facile di fare una ritirata senza ch'egli non entrasse in qualche sospetto, però vedete di scoprire e farmi saper questo ancora. Io son stracio tanto che non posso più perché avevo scritto assai e mi è poi sopragiunto questa vostra alla quale ho voluto rispondere così subito subito senza pensarci e però faccio fine e mi raccomando di nuovo a tutti. Di Padova il primo di novembre 1602.
D. V.S. Ill.re
Aff.mo fratello e Ser.re
Alessandro Barignani

Immediately afterwards, Captain Silla Barignani forwards this letter to Giu. Giordani with the following comment trying to placate the Duke:[1]

> Sig.or Cugino oss.mo
> Il corriero di Venetia ha portato la qui inchiusa di mio fratello quale mando a V.S., acciò La consideri l'integrità sua, e se ne vaglia come Le parerà, essendo certo che alla prudenza e amorevolezza sua non occoreno né avertimenti né preghiere; acciò La continui in favorirne, e in sganar S.A. di quello che La conosce esser bisogno potrà valersi o de concetti o della medesima lettera come meglio Le parerà. Per questo ordinario Le ho scritto quello che dovrà fare per conto della pratica del S.r Giovanni Battista né altro occorendomi a V.S., alle Sig.re Vittoria e Beatrice col S.r Camillo baciamo le mani con augurarLe ogni bene.
> Di Pesaro li 4 Novembre 1602
> D. V.S. M. Ill.re
> Ser.re e Cugino Ob.o
> Silla Barignani

Another letter, about a year later, shows that Guidobaldo's isolation grew more and more: in occasion of the death of his son Carlo, soldier in Flanders at the end of 1603, his two friends from childhood Pier Matteo and Giulio Giordani did not even express there condolences personally: Pier Matteo seems to have written him only a letter,[2] while Giulio appears to have confined himself to make his brother deliver the following message:[3]

> Fratello hon.
> (...) Non so s'io entrarò in altro complimento col S.r Guidobaldo per la morte del S.r Carlo, ma in ogni caso mi sarà caro che gli testifichiate il dispiacer che n'ho preso.
> Stiamo bene tutti dalla Virginia in poi, e Vi salutiamo pregandoVi contentezza e prosperità continova da Dio N.S. Di Casteldurante li 2 gennaio 1604,
> Vostro fratello amor.mo
> Giulio Giordano

Highly interesting is the following letter, that the Duke of Urbino wrote personally to his ambassador Cavaliere Sorbolongo at Rome, who was commissioned to report its contents to the Pope: it is a meaningful testimony of the remarkable repercussions that the exilement of the della-Rovere cousins and Guidobaldo had:[4]

[1] Cf. BOP, ms 425, fol. 210r.

[2] Guidobaldo's answer is conserved at BOP, ms 426, fol. 183r.

[3] Cf. BOP, ms 923; letter of January 2th; letters of this archival unit without numeration, in chronological order.

[4] Cf. ASF, Ducato di Urbino, I, 106, fols. 64r-65v: this archival unit contains many autographs written by the Duke, covering a wide range of topics: administrative questions, reflec-

Avend'io veduto quello che S. Sant.à vi ha detto intorno al Marchese et a Mons.or della Rovere, mi risolvo che siate ai suoi piedi, dicendoli non esservi parso di poter far di meno di non darcene conte, et che io Vi ho comandato a dirli che se bene di cose tali non entrarci a trattarne con altri nel modo che la S.tà Sua intenderà, poiché di attioni simili mi ho da contentar in me medesimo, nondimeno che faccio tanta stima dell'opinione che possa aver di me S.B.ne che la supplico aver per bene[1] che così familiarmente, ma con ogni umiltà li diate conto di qualche causa che a ciò mi hanno mosso, e così li darete minutamente quello che già ve ne scrissi, per conto che la giustitia caminasse come deve[2], mostrandoli bene come questo non è stato se non un termine di farli saper quello che giudicavo esser a proposito[3] non solamente per il buon governo mio, ma per loro stessi ancora, né si è passato a comandamento o ordine alcuno, ma un semplice ricordo come giudicavo convenirmi di far con persone tanto beniffícate da me, quanto si sa, che oltra di questo [nutra] un altro rispetto, del quale non pensavo parlarne, ma con la S.tà Sua coglio dir quello che col Confessor proprio farei, e questo è // che sapendo io la disonesta vita ch'essi facevano e come avendo perduto ogni vergogna non si attendeva se non a cometter publicamente adulterii et altro, credetti con questo che allontanandosi essi di lì, forsi anco potrebb'esser che si raffreddasse questa diabolica furia, ma succede forsi al contrario perdendo bruciandoli troppo questo rispetto. Oltre l'andarne esclamando per le piazze, imperversano in ogni cosa come si vede, di ché poco me ne curo, purché la S.tà Sua sia informata della verità, e particolarmente della natura mia inclinata al bene, e della loro non solamente piena d'ingratitudine, ma di procurare sempre d'accender il fuoco si potessero sin nell'acqua, come anco un'altra volta vi potete ricordar che fecero al tempo di Alfonso Piccolomini.

Questo pover'uomo del Marchese oltra l'inclinatione che pur ha, per poco che conosca a queste cose, si lascia governar da suo fratello e da Hor.<ati>o Alm.<eri>ci Cav.r di Malta.

Il fratello, oltr'il tenere i publici terragli come il Gran Turco, e della più perver//sa natura in ogni altra cosa ancora, che si possa ritrovar, e se bene sa poco, pur tutto il poco che sa lo spende nel peggio che può e non solamente con me, ma con ogni altro. E particolarmente con quel buon vecchio del Vescovo da Pesaro cerca darli ogni disgusto

tions on his last will, edicts as well as letters to Popes, Cardinals, Kings, Dukes. An in-depth study of this folder could turn out to be significant for a historical reconstruction of the last years of the Duchy of Urbino.

[1] aver per bene *signo posito in marg.*

[2] per conto ∼ come deve *signo posito in marg.*

[3] a proposito *signo posito in marg.*

facendo della sua casa un Mont'albano di tutti li più disubidienti e dissonesti preti che vi sieno, talché il pover'uomo più d'una volta ne ha pianto meco. Se con questa occasione vi paresse bene dir qualche cosa di quello che mi toccate intorno ai discorsi che va facendo l'Arcivescovo di Urbino et ai mali modi che tiene non solamente con me, ma con tutto il paese, supp.<onden>do di aver per racc.ta quella chiesa, credo che sarebbe assai a proposito[1].
L'altro, cioè quel Cav.r di Malta, è di quella vita che voi sapete, et ha in se ogn'altra mala parte, sì ché potete giudicar come anderanno le cose sue; a me veramente m'increscе assai, ma non ci voglio pensar più sopra.
Altre infinite cose potrei dir, ma per ora queste mi bastano, non curandomi d'altro senonché S. S.tà creda di me quello che so di meritare, portate Voi tutto ciò con quella riverenza e rispetto verso di S. B.ne che conviene, e coi modi che so molto bene che saprete fare, e se vorrete leggerli questa, così stravagante lettera ben potrete. Rispondendomi a essa poi separatamente anzi anco rimandandomela non volendo io farne copia. Altrimente Iddio Vi guardia. Da Casteldurante alli 18 di giugno del 1602.
Il Duca Vostro

Voltate //
Se vi occoresse dir cosa alcuna con S.S.tà del S.r Guidobaldo del Monte, diteli che il medesimo si è fatto seco, perché si era fatto una certa comunella per la quale le cose della città di Pesaro e di quel comune le facevano andar a modo loro, con molto danno di esso comunee dispiacer delle genti quieti, e da bene a che ho mirato sempre di rimediare, con ogni mio potere, et ora che mi trovo nell'età che sapete son per farlo anco più ardentemente, essendo risoluto che le cose vadino per la via del carro, e che quanto Iddio pur volesse ch'io non lasciassi di me successione, voglio che la S.ta Sede Ap.ca ritrovi il suo quieto et accomodato, conoscendo che così mi conviene di far non solamente come a vassallo fidelissimo, ma anco come chrisitano e Cav.ro d'onore.
Non vi paiano poi questi offiti troppo gagliardi, perché come vedrete alla giornata, sono più che necessari avendo costoro dato in senso reprobo, e facendo vero dal canto loro quello che si dice, che un grand'obligo chiama una grande ingratitudine, ma di questo non voglio dir altro per ora.
Il medesimo.

[1]Se con questa occasione ∼ sarebbe assai a proposito *signo posito in marg.*

I.6 From the nineties to his death in 1607

I.6.1 1590: Again in Tuscany

Guidobaldo went to Tuscany also in 1590. In fact, in November 1589 the Grand Duke of Tuscany personally had approached to Francesco Maria II asking him to give Guidobaldo the permission to come again in Tuscany:[1]

> Ser.mo Sig.re
> Ho avuto molto caro intendere dalla lettera di V. Alt.za de X <di novembre> che Le abbia satisfatto l'ampolla dell'olio, et a suo tempo non lasserò tenerne provista.
> In tanto per valermi delle Sue amorevoli offerte, prego V. Alt.za a farmi gratia di comandare al S.r Guidobaldo dal Monte che se ne venga fin qua da me, perché desidero valermi di lui in alcune mie fortificationi, che me ne farà piacere molto singulare.
> Et Le bacio le mani che Dio La prosperi. Dal Poggio il dì XXII di novembre 1589.
> Di V. Alt.za
> Ser.re
> Il Granduca di Toscana

We know that Guidobaldo arrived on January 12th 1590 in Leghorn and rested there until February 9th.[2] Under the title (p. 25) "First class of guests arrived after the marriage 1589" we find, amongst figures like the Archbishop of Bari, the Cardinals Gaetano, Gioisa, Sforza and the Duke of Luxembourg, also Guidobaldo (p. 27):

> Sig.r Guido Baldo dal Monte arrivò in Livorno alli 12 di gennaro, fu alloggiato in fortezza, servito in argento da staffieri, con un piatto di sua tavolo, 4 bocche in tinello e 5 cavalli alle stalle; e partì il dì 9 de febraro con una nostra lettigha.

Guidobaldo's further route is unclear. Anyway, his rather long stay in Leghorn seems to have been connected with the laying of the foundation stone of the *Fortezza Nuova* which happened on January 10th. Yet, the plural used by the Grand Duke – "I would want to recur to <Guidobaldo> for *some* of my fortifications"[3] – suggests that Guidobaldo had to fulfill tasks also in other cities.

A *terminus ante quem* for Guidobaldo's return to the Duchy of Urbino is given by the following letter to Galileo, sent on April 10th. Guidobaldo tells to have

[1] Cf. ASF, Ducato di Urbino, I, 236, fol. 291r; copy with autograph signature.

[2] Cf. ASF, Diari di Etichetta di Guardaroba 1, pp. 25-27. The following passage is published in M. Biagioli, *The social status of Italian mathematicians 1450-1600*, in "History of Science" XXVII, 1989, pp. 41-95.

[3] The emphasis is ours.

"passed through Bologna", he could refer here to his return from his inspection of the fortifications:[1]

Figure I.3: The *Fortezza nuova* at Leghorn.

Figure I.4: The sign in front of the *Fortezza nuova* confirms the 10th of January 1590 as day of the laying of the foundation stone.

> Molto mag.co et ecc.te S.r mio.
> Mi è sommamente caro di aver nuova di Lei, ma io non resto compitamente satisfatto perché La vorrei veder più contenta e meglio trattata, secondo li meriti suoi. Io non ho avuto per ancora nuov'alcuna da Venetia, ma io cercarò di saper qualche cosa e non mancarò di avisarGliene.
> Gli dico bene che passand'io da Bologna domandai del Magino, il qual non viddi se ben mi fermai in Bologna due giorni e più. E parlando con alcuni, et in particolare con un dottore che legge in Studio, com'egli si portava et come serviva bene, mi rispose che si portava male e che non sa dimostrar niente, et che quando replica qualche cosa, dice che sempre dice le medesime parole, et quelle apunto che sono in Euclide, sì che non ne restano satisfatti. Et io con questo campo dissi che in Fiorenza ci era un mio amico il qual oggi legge in Pisa etc., dove mi slargai sopra V.S. a mio modo. Ma intesi che la condotta del Magino dura ancor un anno e mezzo, se ben mi ricordo, e non potrà far che, o per una via o per l'altra, non si facci qualche cosa.
> Io ho poi trovate alcun'altre cose sopra la coclea, le quali non l'ho

[1] Cf. BNCF, mss. Gal., P. I. T. VI, fol. 9, published in Galileo, *Opere*, vol. X.

ancor ben scritte; come io le averò in esser, so che mi favorirà di vederLe perché gliele mandarò, perché come io avrò il suo giudizio sarò satisfatto. Fra tanto mi comandi, e Le bascio le mani. Di Monte Baroccio alli 10 di aprile del 1590.
Di V.S.
Ser.re,
Guidobaldo dal Monte

I.6.2 Hints at Guidobaldo's scientific work in the nineties

The following letter from Guidobaldo to Galileo is interesting for several reasons: on the one hand, it testifies the favours that the former did to the latter (contacting his parent Giovan Battista dal Monte, his involvement in Galileo's appointment as professor at Padua). Further, it contains information about Guidobaldo's scientific work in the early 1590s: apparently, Guidobaldo had made progresses with his works on the *Perspectivae Libri sex*, but then they got stuck:[1]

Molto mag.co et Ecc.te S.r mio hon.do,
io hebbi una lettera di V.S. quando Ella era in Fiorenza per tor licentia per poter andar a legger a Padova, alla qual risposi; dove desideravo, come desidero ancora, di saper che privision gli danno, perche io vorrei che ella fusse trattata secondo il desiderio mio et i suoi meriti.
Gran contento ho poi preso in veder che habbi dei scolari assai, che spero che con il suo valor farà di maniera che molti attenderanno a questa scienza, et glie la fara conoscere perche invero ella non e conosciuta se non da molti pochi.
Io non mancarò con l'occasioni che mi presentaranno, di scrivere al Signor Gio. Battista dal Monte di quanto mi ricerca. Quanto poi che mi vogli haver obligo del luogho di Padova, io non voglio per niente che me ne habbi obligo, non havendoci io fatto niente, ma il tutto lo dia al suo valore et la suo molto sapere.
La mia *Prospettiva* mezzo dorme e mezzo vegghia, che a dir il vero io ho tante le occupazioni che non mi lasciano respirare, et per queste cose bisognarebbe esser libero da ogni fastidio. Pur la voglio finire, et hora sono atorno per accomodargli il principio, trattando dove si ha da metter l'occhio accio le cose si possino veder secondo che vogliamo; ma non ho ancora trovato ogli cosa, e prima di ogn'altra cosa ci vorrò poi il Suo giuditio. E Le bascio le mani, come fa mia moglie e tutti.
Di Monte Baroccio alli 10 di gennaro del 1593.
Di V.S.

[1] Cf. BNCF, mss. Gal., P. I, T. VI, fol. 19.

Serv.re,
Guidobaldo dal Monte

Also the following letter informs about the works on he *Perspectivae Libri sex*. It suggests, *inter alia*, that initially Guidobaldo had thought to publish first the *Cochlea* and only then his writing on perspective, but then changes his mind. In effect, while the *Perspectivae Libri sex* was released in 1600, the *Cochlea* was published only posthumously in 1615:[1]

> Molto mag.co et ecc.te S.r mio hon.do,
> mi saria stato carissimo che V.S. fusse passata di qua, che oltre al contento gl'averei mostrato volentieri alcune cose della mia *Prospettiva*, la quale in questo verno spero di finirla, et ho già dissegnato i due terzi delle figure, e vo risecando e levando via piu cose che posso, perche in vero mi riesce lunga. E circa il darla fuori mi sara necessario d'aspettar che le figure si finischino d'intagliare, che Francesco mio servitore non ci può troppo attendere, sì che non credo che possino esser finite di qui a un anno. Io desidero di levarmela dinanzi che non la posso piu vedere; anzi sono in animo di mandar fuora prima la *Prospettiva* e poi la *Cochlea*.
> Io scrissi a questi giorni un'altra mia a V.S., ma Ella doveva esser a Fiorenza, e gli davo nuova che un dottor Adriano Romano di Lovanio mi ha mandato a donar un libro suo che lo chiama *Ideae mathematicae sive Methodus polygonorum* il qual tratta del descrivere le figure poligone, ma per via di calcolo, tutto per via d'approssimazione con i numeri; e ci sono le propositioni e le praxi, ma non c'e niuna dimostratione, che me ne sono molto meravigliato.
> Al Signor Pinello V.S. farà un bascia mani, ringratiandolo che tenghi memoria di me, e Gli ho invidia che vorrei esser ancor io tal volta alli loro colloqui. E Le bascio le mani, e mi comandi. Di Monte Baroccio alli 3 di settembre del 1593.
> Di V.S.
> Ser.re,
> Guidobaldo dal Monte

Remarkable are Guidobaldo's repeated claims to intend the finish the *Perspectivae Libri sex* in the near future: yet, it would have still taken not less than seven years, until it finally appeared. In this context, his complaint that "to be honest I have so many occupation that do not let me breath, and for these things <studies on mathematics> on would have to be free from any disturbance" is highly interesting: it hints at the fact that Guidobaldo's time for scientific studies was seriously limited in the 1590s.

[1] Cf. BNCF, mss. Gal., P. VI, T. VII, fol. 32.

I.6.3 Clement VIII's visit to Pesaro in 1598

A remarkable event in 1598 was Pope Clement VIII's passage at Pesaro, in connection with the devolution of the Duchy of Ferrara to the Pontifical State. The following account of Domenico Bonamini gives an idea about the festivities in this context:[1]

> 1598 3 Maggio: Questo tempo fu assai memorabile per la città nostra per la venuta, stanza e ritorno del Pontefice Clemente VIII Aldobrandini. L'infrastritto sarà il ristretto della Relazione cavato dal ms di D. Giulio Cesare Tortorini a <pagina> 49 Ms Montani.
> Andarono sino ai confini 3700 soldati, e si posero in ordinanza. Sull'ore 13 il Ser.mo Duca Francesco Maria II si portò quasi ai confini con 100 cavalli e più e tutti i suoi gentiluomini riccamente vestiti con due e tre staffieri a livrea. Sull'ore 17 venne il Papa con 1500 cavalli, 3000 persone, 28 carozze sue ed altretante delli Sig.ri Cardinali ed altri Signori. La nostra soldatesca in fila arrivava dalla Chiesa del Carmine vecchio al confine di Fano.
> Il Papa scese dalla lettica e salì a cavallo. Il nostro Duca veduto il Pontefice smontò da cavallo per cento passi innanzi ed a piedi in compagnia del M.se della Rovere, del Cav.r Sorbolongo, del Con. Carlo Gabrielli, del Sig.r Giulio Giordani si appressò in ginocchiandosi sopra un scabelletto, e baciando il sinistro piede di S.B. che baciatolo tre volte lo abbracciò con grandissimo amore piangendo ambedue per tenerezza. Volle il Pontefice che il Duca salisse a cavallo e che andasse seco al pari lo che però non eseguì il nostro Duca andando sempre la testa del cavallo addietro.
> Quando giunsero al Carmine fu fatta la salva degl'archibugi per la terza volta e quindi in città furono sparate 200 codette, ed undici pezzi d'artiglieria, e sopra le muraglie altri 28 pezzi. Il concorso del Popolo fu innumerabile, e fu [riportato] 30 o 40 mila persone, che il Papa benediceva giubilando e ridendo a cavallo d0una candidissima mula in vestimenti papali viatori. Era seguito da 16 cardinali, alcuni de' quali erano Aldobrandini, Sforza, S.Giorgio, Farnese, Montalto, Baronio, S. Clemente, Galli, il nostro Cardinal del Monte, Bianchetti ed altri.
> Nel entrare la città, S.S.tà passò sopra le porte di quella che levate dai cardini per terra erano rivolte in segno d'ubbidienza e gli si dettero le chiavi. // Il magistrato vestito di paronazzo lo aspettò sotto la porta, e sotto un leggiadro baldachino turchino lo condusse fino al Duomo passando per due archi trionfali bellissimi, in uno de' quali posto innanzi la Piazza era figurata la ribenedizione fatta da S.S.tà del Re di

[1] Cf. BOP, ms 966, pp. 146-150.

Navarra. Arrivato in Duomo fatte le debite e solite funzioni fu intonato in musica l'*Ecce Sacerdos magnus* il quale finito dopo poco tempo il Pontefice uscì di chiesa nobilmente apparata, e salendo nella sedia da viaggio si fece portare in corte seguitato a piedi dagl'eccelentissimi carindali e Ser.mo Duca. A piedi della scala trovò la Ser.ma Madama d'Urbino, madre del Ser.mo Duca che gli basciò il piede e da S.S.tà fu abbracciata con grandissima cortesia dicendole "Madama mia levatevi su" ed allora lo baciarono l'Ecc.mo M.se del Vasto di Pescara e d'Avalos, ed andò S.S.tà alle sue stanza passando per la sala della credenza ornatissima di vasi superbissimi d'oro ed argento e per le camere papali splendidamente apparate di brocato d'oro e seta di color rosa secca con un letto gentilissimo ed un tavolino splendidissimo per le gioie intrecciate in essi.
Quivi S.B. si ritirò, e dopo poco tempo gli fu portato il piatto dai suoi camerieri e nei suoi piatti e non in quelli del Ser.mo che ne aveva a tal fine preparati 100 tutti indorati. S.B. volle seco a pranzo il Ser.mo che stette però in tavola separata da quella di S.S.tà un piede o due, ambedue da una banda. Alle ore 19 ebbero vari ragionamenti allegri e non entrarono che due gentiluomini del Ser.mo e lo scalco.
Mentre pranzò S.S.tà fecero lo stesso tutti i forestieri. Nella sala grande desinavano in tre tavole 200 persone di varie sorti di qualche qualità. In altra sala longa oltre 200 persone basse. Nella sala longe delle credenze 33 tra prelati ed alcuni pochi gentiluomini. I cardinali mangiarono tutti separatamente ne' loro appartamente oltre i loro gentiuomini che formavano tavole quindici. Aldobrandini nelle camere basse del Ser.mo a pian terreno. Sforza nelle due camere della galleria. S. Giordio in quelle della Piazza di sopra. Farnese <in> quelle della Duchessa sopra il giardino. Montalto in quelle della Sig.ra [M.se] della Rovere. Baronio // <ne>i camerini. S. Clemente <nel>le stanza del Convento S. Angelo. Galli alloggiò dal Baregnani. Del Monte a casa sua. Bianchetti dal M.se della Rovere. Altri dal Vatielli, dal Ragusio, dal Tomasi, Macigni, Tortora e nostro vescovo <Cesare Benedetti>.
A tutti questi in piatti d'argento ed oro era portato fino alle loro case dove alloggiavano, la provisione mandato loro dal Ser.mo Duca. Nel tempo che S.S.tà definò, cinquanta giovani vestiti di drappo turchino ed oro con infinite perle e gioie alle berette coi bastoni dorati in mano condussero per la città alla vista del popolo la chinea del Papa col suono di 8 trombe, nel qual fratempo la soldatesca fece di sé bella msotra nella piazza coi superbi vestiti colle numerosissime picche e colle penne in testa di vari colori. Gli Eminenze alle finestre ammirarano il bell'ordine di tale soldatesca; quindia quattro a quattro andarano a far visita alla Ser.ma e finalmente all'improviso fu veduto venire S.S.tà a tale effetto. Si posò a sedere facendo cerimonie colla

Ser.ma che novamente gli basciò il piede, come fecero lo stesso ancora altre 15 dame chi erano seco lei, cioèle sopradette Marchesi, la Sig.ra Felice del Monte della Rovere, la chiarissima Pellegrina veneziana, e la Sig.ra Orsola Buboli gentildonna ragusea. Si tratenne S.S.tà per un'ora e mezza in segreti ragionamenti colla Ser.ma e quindi si ritirò sino allora di cena.
La sera cenarono nell'istesso modo della mattina e S.S.tà mangiò solo e ritirato circa all'ora di notte. In questo fratempo il Pontefice mandò a regolare quattro bellissime corone d'agate alla Ser.ma, alla M.se di Pescara sposa, alla sorella Sig.ra Cattarina ed un'altra alla Sig.ra Maria complenarie. Indulgente nonostante ch'egli avesse fatta la nota Bolla contro l'indulgenze e loro ristringimento, la Ser.ma regalò al Pontefice un bellissimo orologio con la sua cassa coperta di veluto rosso ed oro, che sonava ore, quarti e svegliarino. Il Ser.mo Ducauna credenza d'argentario dentro un scaldaletto ed un quadretto fatto da dottissima mano; ed il Pontefice in contracambio un crocefisso d'oro in una cassa foderata di veluto nero, che fu posto la mattina nella capella dove S.S.tà // disse la messa coll'intervento della Ser.ma e dell'altre Signore e del Ser.mo, che gli presentò il sciugatoio al lavabo, benché il Pontefice non lo volesse a lui restituire ma ai capellani serventi.
All'ore 13 e mezza del giorno 4 maggio partì coll'istesso ordine col quale arrivò, avendo presso sé il Ser.mo Duca coi 50 giovani pesaresi, ai quali quando fu lontano mezzo miglio da Pesaro chiamato il decano de' suoi palafrenieri fece a lui consegnare settanta doppie d'oro del tesoriere, acciò fossero regalati <a>i 500 giovani, e con questo facessero un convito tra loro.
Volle ch'ivi rimanessero quei tali giovani ed il Ser.mo Duca seguì ad acompagnare il Pontefice per tre miglia ed allora S. S.tà lo licenziò con gratissime parole, benché i soldati pesaresi fossero sparsi sino i confini, quali ingenocchiati e volte le bocche degli archibugi e picche in terra furono benedetti e quindi tornarono alle loro abitazioni.
Il Ser.mo tornò a Pesaro accompagnato dalla cavalcata e cinquanta giovani, che nell'entrare della città gridarano col popolo "Viva Viva il Ser.mo d'Urbino Magnifico" ecc. e dimostrarono con questo lo sviscerato amore che portavano a questa Ser.ma Casa della Rovere sotto la tutela e protezione della quale desideravano vivere lunghissimi e felicissimi anni.
Otto giorni innanzi della venuta del Pontefice era preceduto il Santissimo Sacramento portato in un bellissimo tabernacolo d'oro colla capella della musica papale, portato sopra una chinea bianca ornatissima, e con una cavalcata di circa 80 cavalli.
Furono donati dal nostro Duca alla guardia officiale e palafrenieri del

> Papa alcuni centinaia di scudi e si dimostrò in tutto assai generoso. // (...)
>
> Clemente VIII, dopo d'essersi insignorito di Ferrara senza spargimento di sangue, *Ferraria sine clade reconquista*, ritornò a Pesaro la mattina di buon ora il 7 dicembre 1598[1] ed andò a celebrare la messa alla Cattedrale. Erano con lui molti cardinali, il nostro Signore Francesco Maria II colla Madre Madonna Vittoria Farnese. Finita la messa senza tornare in Corte s'incaminò verso Fano.
> Il nostro Duca lo acompagnò colla sua corte fuori di Porta Fanestra sino alla Madonna del Carmine e lì, fatti i scambievoli complimenti, si lasciarono. Il Papa montò a cavallo nella chinea sino a Morelli, luogo di oggidì Muraglia ed ivi, presi varie ova fresche, andò a Fano a desinare. Discorresi di tale passaggio nei Consigli di quest'anno a <pagina> 216.
> E' da notarsi che questo Pontefice Clemente VIII era figliuolo dell'Aldobrandini bravo legale stato già Uditore per molti anni dei Duchi d'Urbino e che aveva fatta la sua ragazzeria nella città nostra, onde a lui era ben cognito il materiale del Paese. Questa è poi forse la cagione del vedersi tanti Brevi in quest'anno diretti al nostro Duca da questo Pontefice in numeri di quattro esistenti nel Tom. I originali a <pagina> 196 XLII. Con quello in data dei 9 dicembre ringrazia il Duca delle attenzioni usategli nel passaggio per Pesaro. Gl'altri furono spediti sotto il dì 4 febbraio, 23 aprile, 4 luglio di quest'anno 1598. Il Breve del dì 4 febbraio è stampato nel Fontanini, Ragioni di Comacchio a <pagina> 407.

The records of the Council of Pesaro shed light on Guidobaldo's involvement in the preparations for Clement VIII's visit.[2]

> Die 9 Ianuarii 1598
> Congregato consilio magnificae civitatis Pisauri de ordine et cum interventu excellentis domini Horentensii Fidi Locumtenentis ducalis.
> Nel quale intervennero: il Signor Alessandro Barignani Confaloniero, ser Paolo Emilio Arduini (...); e dal Signor Confaloniero fu raggionato come qui sotto:
> sentendosi tuttavia continuare et augumentarsi la voce et fama che Sua Santità sia per venire a Bologna, et conseguentemente passare per la nostra città di Pesaro, et trovandosi che in altra occasione de' viaggi de' Papi è stato solito delle città per dove è occorso questo

[1] 7 dicembre 1598 *in marg.*

[2] Cf. ASCP (BOP), Atti del Consiglio 1580-1609, II C 1, fols. 215r-216v. For further information on this topic, cf. G.G. Scorza, *Pesaro fine secolo XVI. Clemente VIII e Francesco Maria II della Rovere*, Venezia, Marsilio, 1980.

passaggio di fare alcuni preparamenti et apparecchi particolari per ricevere Sua Santità con quell'onore e decenza che conviene, e perché potrebbe occorrereche si sapesse così presto la certezza della venuta che non ci fosse più tempo a fare tutte quelle provisioni e diligenze che si ricercano, però viene giudicato raggionevole e conveniente di mettere in considerazione a questo magnifico Consiglio il pericolo che ci soprastà di non esser colti sproveduti et in necessità di mancare di quelle onorate dimonstrationi di grandezza et magnificenza che ha sempre mostrato, ini tutte l'occasioni che per i tempi passati si sono presentate, questa nostra città, che oltre il biasimo e pregiuditio che se ne potrà ricevere nella riputatione, non potrà essere se non di mala sodisfattione e disgusto del Signor Duca Serenissimo che deve essere stimato da noi principalmente. (...)
La prima diligenza dunque che suole farsi è di fare adornare et addobbare, più pomposamente che sia possibile, tutte le strade della città per dove ha da passare Sua Santità facendosi particolarmente delli archi trionfali;
Si fa provisione di due baldachini uno di drappo di colore bianco con pendoloni e grangi d-oro con l'arme del Santissimo Sacramento di Sante Chiesa e di Sua Santità per ricevere il Santissimo Sacramento; l'altro si fa di drappo di colore rosse con i medesimi pendoloni e frangi d'oro con l'armi di Santa Chiesa e di Sua Santità; (...)

Restarà dunque che si venghi all'ellittione delle persone che dovranno aver la cura e peso di far fare gli archi trionfali, l'apparato delle strade, i vestiti dei gioveni et il badachino. (...) E propose l'infrascritto partito: chi vuole che siano deputati, soprastanti agli archi trionfali da farsi per la venuta di Sua Santità, il Signor Guido Baldo del Monte, messer Paolo Arduini, messer Claudio Saiani, messer Nicola Leonardi et messer Curtio Arditio, li quali abbino peso et autorià piena come ha il medesimo Consiglio, di elleggere dissegni per gli archi, deputare i luoghi dove dovranno farsi, provvedere che sia pronto il legname et altre materie necessarie, far diligenza per aver marangoni, muratori, pittori, scultori et altri artefici che faranno bisogno, considerar la spesa che ci andarà, senza però dar spesa alla communità, e venendo il caso che si abbino a fare, che possino farli et stabilirli compitamente come a loro parerà, dandone però, dopo la certezza della venuta del Papa, informatione al Consiglio acciò se li possi fare assegnamento per la spesa che ci entrarà, dia la palla del sì e chi non vuole la dia del no.
Messer Claudio Saiani si iscusò per molti impedimenti che allegò avere.
Si venne poi alla ballottatione e fu ottenuto il partito sudetto per palle

30 del sì, nonostante cinque in contrario.

I.6.4 The year 1606

The following entry of the Council Records testifis Guidobaldo's involvement in a political question in the year 1606, shortly before his serious disease and his subsequent death in 1607:[1]

> Die 14 Julii 1606
> Congregato Consilio [Per.] Ill.ris Civitatis Pisauri de ordine et cum interventu Ull.ris et adm. Exc.tis D. Jo. Bapt. Balentini l.ntis ducali dicti civitatis. (...)
> Essendo che del mese passato s'ordinasse dal Ser.mo P.rone per lettera di udienza che a mezo il mese presente si mandassero persone in udienza per la competenza di precedenza che pretene la città di Gubbio con questa di Pesaro furono dal consiglio passato deputati a questo il Sig. Montanari e m.s Gaspar Genga. Ma perché il Montanaro si ritrovava impedito dalla gotta, che pareva impossibile potesse tran//sferirsi a Casteldurante martedì passato in una congregatione, fu rissoluto che si supplicasse S.A.S. per proroga di alcuni giorni come fu fatto per una lettera nostra della quale si è ottenuto risposta come le Ss.rie Vv. intenderanno da essa che essendo il Montanaro impedito se n'ellegga un altro in luogo suo, overo si mandi il Genga solo, non si dovendo per ora discorrere de' meriti ma solo concordare in un giudice per instruire il processo. (...)
> Chi vuole che si elleggano li sottoscritti che abbino autorità di trattare quel tanto che occorrerà in questo negotio di Gubbio con intervento del magistrato per tempore mentre gli uomini elletti staranno alla corte, e doppoi ancora se cosa alcuna vi restarà fare e che da essi si debba rispondere alle lettere di detti elletti e che in somma gli uomini sottoscritti o maggior parte d'essi dal concludere accordo [impur] si fosse caso d'accorde che non si crede per essere il negotio chiaro e terminato a nostro favore, la conclusione e stabillimento del quale accordo [fol. 331r] s'intenda in tal caso riservato al consiglio, possino in questo negotio far e deliberare quel tanto che può in consiglio, dia la palla del sì e ch non vuole la dia del no.
>
> Sig.r Guidobaldo del Monte[2]
> m.s Fabio Benedetto
> m.s Baldo Amatorio
> m.s Claudio Saiani

[1] Cf. ASCP (BOP), Atti del Consiglio 1580-1609, II C 1, fols. 328v-331r.
[2] Elletti a trattare il negotio di Gubbio mentre gli altri elletti sono alla corte *in marg.*

m.s Ludovico Germani
m.s Antonio Paoli
m.s Francesco Maria Tomasi
m.s Silvio Zannettini
m.s Romolo Tortora
m.s Ludovico Pretis
m.s Giovanni Ondedei
m.s Francesco Zucchella
Item m.s Gio. Batt.a Montanari, m.s Pier Simone Bonamini, m.s Gaspar Genga per quel tempo ch'essi si trovaranno a Pesaro e che si trattarà di questo negotio.
Fu ottenuto il partito sodetto viva voce levandosi in piedi tutti i consiglieri.

A confirmation of the information contained in BOP, ms 758 that Guidobaldo in November 1606 fell seriously ill is contained in the records of the Council of Monte Baroccio. The entry of November 26th 1606 reads:[1]

Laus Dio
A dì 26 novembre del 1606
Fu adunato il Consiglio al suono della campana nella sala solita del Palazzo del Comune con la presentia del Signor Podestà con li sottoscritti consiglieri:
(...)
Fu anco proposto di andare a visitar l'Ill.mo Sig.or Guidobaldo che è amalato et portarLi quattro *** in nome della comunità. (...)

[1]Cf. ACM, Libri del Consiglio, 1600-1622, fol. 143r.

I.6.5 Guidobaldo's last wills of 1597 and 1607

Researches over several months in the Marchigian archives and libraries have brought to light *inter alia* Guidobaldo's last will. To be precise, there have been discovered two; the first registered on July 1st 1597, the second on January 4th 1607. The present subsection exposes their transcription:

Guidobaldo's and Felice's last wills of 1597[1]

In Christi nomine amen. anno ind. Pont. p.is die prima Iulii.
Illustrissimus Dominus Guidus Ubaldus de Marchionibus a Monte, Montis Birocii Comes nolens intestatus decedere sciens se morti subiectum et mortis horam ignorans ideo constitutus sponte et presente coram testibus et me Notarium infrascrire sanus Dei gratia mente, visu, sensu et intellectu ac corpore de suis bonis praesens nuncupativum testamentum quod dicitur sine scriptis in hunc qui sequitur modum disposuit videlicet:
Nam inprimis animam suam de corpore egredientem omnipotenti Deo, Jesu Christo redemptori, Beatissima Virgini Mariae et omnibus santis umiliter et obnixe commendavit. Cadaver vero suum sepellire iussit sine pompa funerali si Pisauri mori contigerit in ecclesia[2]. Et si in Terra Montis Birotii mori contigerit in ecclesia Sancti Viti, si autem alibi in ecclesia viciniori loco mortis. //
Pro incertis male ablatis Monti Pietatis, ecclesiae Cathedrali Hospitali unionis, pro concimine portus Pisauri et passu ultra [mare] quot bononenos decem pro quolibet loco dicto semel tantum.
Gravavit iure legati, et omni alio meliori modo inf.<im>os Ill.mos suos haeredes ad erogans religiosis scutos duodecim in annum a die suae mortis ut celebrentur tot missae ad altaria privilegiata pro eius anima.
Reliquit iure restitutus partis suarum dotium, et iuris legati, et omni alio meliori modo Ill.mae Dominae Foelici a Ruvere eius dilectae uxori [praesidium] in corte Scapezani pro tanto quantum est, et cum eius qualitatibus iuribus et pertinenti pro eodem praetio quo emptum fuit asserens fuisse emptum propriis pecuniis dotalibus D. Ill.mae Foelicis. Et eodem modo et iure reliquit eidem Ill.mae D. Foelici possessionem in corte Pisauri in fundo Soriae et pro eodem praetio, pro quo emptum fuit, affirmans emptum fuisse propriis pecuniis dotalibus D. Ill.ma saltem pro maiori parte; cum declaratione quod omnia sumpta bona Scapezani et Soriae habeat integra modo et termino ac statu [praeter temporem] mortis dicti Ill.mi talia bona reperientur et erunt et cum omnibus melioramentis, bonificamentis, aquisitionibus et augumentis quae facta essent ultra primas emptiones, etiam si in talibus locis alia bona aquisita essent, et in futurum aquirerentur, et cum [inestibus] qui in eis tempore suae mortis pendent et extarent, et noluit

[1] Cf. ASP, fondo Notarile, Vasconi Giovanni, anno 1597, III parte, busta 1732, fols. 240r-243v.

[2] *post* ecclesia *spatium aliquot verborum rel.*

imputari in dicta dote nisi partium priorum emptionum fastarum in dictis locis quia residuum eidem iure legati reliquit et sic sibi facere placuit.
I[tem] eidem Ill.mae Dominae Foelici iure legati reliquit usum et habitationem in propria domo habitationis dicti Ill.mi cum omnibus illis commoditatibus quae convenirent qualitatibus Dominae Illustrissimae cui omnia administraverit et in futur[um] administrare posset quo ius tempore in totum vel pro parte // res et bona d. Ill.mi et haereditaria post eius mortem tam respectu partis filiorum eorum maiorum viginti quinque annis, [quorum] minorum reliquit iure legati et omni alio meliori modo omne id, et totum in quo ipsa peteretur vel reputaretur vel condemnaretur debitrix occasioni dictae administratonis [quoniam] ipse Ill.mus multum se confidere dicit in fide et synceritati dictae Ill.mae et amore ac dilectione quibus scit ipsam communes filios prosequi [mandatis] suis filiis et haeredibus inf.<im>is ne ipsam circa ** molestent aut inquietent.
Ad.m Reverendae et Illustrae Sorori Juliae eius Germanae in conventu Sancti Corporis Christi ab Pisauro reliquit grossos decem pro quolibet mense durante eius vita, et eodem iure legati reliquit admodum Reverendis et Illustrissimis Sororibus Francescae et Clarae eius filiabus, sororibus in detto conventu scutum unum pro mense cuilibet earum donec vixerint corporaliter; et ita ut morientis pars alteri non acrescat, sed exstintum sit legatum. Pro ratu morientis, quibus eius filiabus dum vivent eodem iurem reliquit vestimentum [vix] earum indigentium, rogans Reverendas Abbatissas et moniales dicti conventus pro tempore, et earum superiores, ut pro claritate et amore Dei permittant dettas Sorores Juliam, Francescam et Claram posse pro earum usibus, indigentiis commoditatibus et occurrentiis frui et potiri dicto legato ea consequi et exigere quia sine hac spe legata [testurus] ut [dicit] non esset sperans et ut conventus ex hoc sublevetur ab aliquali onere versus eas.
Illustrissimo Domini Horatio eius filio reliquit iure pro legati omnes eius libros Mathematicae et etiam tutti li cassettini, stucci, compassi, ferri, bossole, modelli, et tutti gl'instrumenti e disegni stampati et non stampati, et anco ogni altra cosa appartenente a questa professione di matematica, et tutti gl'altri libri suoi poi siano e debbano essere // come lasciò per ragion di prolegato, al S.r Alessandro altro suo figlio et a tutti gl'altri suoi figli che attendessero alle lettere.
In omnibus autem aliis suis bonis presentibus et futuris propriis et [emptis] eis iuribus et actionibus [quam] suos haeredes universales instituit, proprio ore nominavit Ill.mos Dominum Francescum Mariam, D. Carolum, D. Alexandrum, D. Horatium, D. Uguccionum, D. Honofrium, et D. Johannum, eius filios leg[alissi]mos et naturaliter natos, ea se, et detta Illustrissima D. Foelice aequaliter, et pro portionibus aequalibus et pleno iure.
Hanc autem dictus Illustrissimus Dominus testator dicit esse et velle esse eius ultimam volontatem, et ultimum testamentum [quam] et quod dicto iure nuncupativi testamenti valere voluit; et si dicto iure [non] valent, valere voluit iure codicillorum vel donationum causa mortis, et omni alio meliori modo.
Cassans et annullans quascumque alias ultimas voluntates.

Volens hoc presens testamenti caeteris preferri.
Actum, factum, conditum et ordinatum fuit praesens testamentum per dictum Dominum testatorem Illustrissimum presentem et ut supra disponentem scriptum autem ad perpetuam rei [memoriam] et probationem; et publicatum fuit per me Notarium eiusdem mandato sub anno ind. die et pont. in conventu Capucinorum Pisauri in mansionibus superioribus in monte Sancti Bartholomi Syto extra Portum Pontis.
Presentibus Reverendis Prioribus Patre Fratre Iusto de S.to Iusto Guardiano, 2 Patre Fratre Io. Baptista de Borronin, 3 Patre Fratre Constantio Bergome, 4 Padre Fratre Paulo de Pisauro, 5 Patre Fratre Nicolao de Spalatro, 6 Patre Fratre Corado de Offida, 7 Patre Fratre Alexio de Monte Cicardo testibus ** adibitis vocatis, et ore pro p.o dicto Illustrissimi Domini testatoris rogatis et omnibus Capucinis et residentibus modo in dicto conventum.//

In Christi nomine amen. Anno Iud. Pont. et die primis <Iulii>.
L'Ill.ma S.ra la S.ra Felice della Rovere moglie dell'Ill.mo Sig.r Guido Baldo de' Marchesi del Monte Conte di Monte Baroccio sana per la Iddio gratia, della mente, del vedere, intelletto et corpo raccordevole d'esser mortale, et di non sapere l'ora della morte non volendo morir intestata dispose de suoi beni per il presente nuncupativo testamento che si chiama senza scritti nel modo seguente cioè:
Prima ordina et vuole che accadendo la morte sua in Pesaro il suo corpo sia sepelito nella Chiesa delle monache del Corpo di Christo però nella chiesa di fuori dove si suol celebrare la messa; et se mancasse di questa vita in Monte Baroccio vuole che il suo corpo sia sepilito nella chiesa di S. Vito del medemo luogo, et se morisse in ogni altro luogo vuole che il suo corpo sia sepelito nelle chiesa più propinqua al luogo dove morirà con chiamare a quest'effetto li soli religiosi di quella chiesa senza spesa straordinaria di sorte alcuna.
Et per salute dell'anima sua ordina, e vuole che dalli infrascritti suoi eredi siano per cinque anni continui, e non più oltre dati e passati per elemosina alla chiesa dove ella sarà sepolta, e religiosi che vi saranno di tempo in tempo duranti li cinque anni scudi tre per anno per dire tante messe basse senza cerimonia di messe cantate per l'anima di essa S.ra testatrice. //
Per il passo oltre il mare, per le cose incerte mal tolte alla Chiesa Catedrale Hospitale dell'Unione Monte della Pietà, et per il [concimo] del Porto di Pesaro lasciò per una sol volta bolognini dieci per ciascun di detti luoghi.
Lasciò per legato a D. Giovanna[1] sua serva per averla servita bene et fedelmente per molti anni scudi cinquanta oltre quello che ha avuto, acciò si possi accomodare dei [mobili] che gli faranno bisogno e questi gli lassa per elemosina, se sarà però viva al tempo della morte di essa S.ra Testatrice altrimenti annulla il legato.
E perché Ludovico[2] ha servito ancor lui per molti anni fedelmente però se sarà

[1] *post* Giovanna *spatium unius verbi rel.*
[2] *post* Ludovico *spatium unius verbi rel.*

vivo al tempo della morte di essa S.ra Testatrice gli lassa per elemosina scudi cinquanta. La dichiarazione che questo legato, e l'altro simile fatto alla soprascritta D. Giovanna debbano pagarsi dall'infrascritto suo erede o eredi con commodità di tempo la quale dichiara e vuole che non passi cinque anni dopo la morte di essa S.ra Testatrice.
In tutti gl'altri suoi beni mobili, stabili, ragioni, attioni proprii, ** presenti et futuri, sono erede universale di piena ragione nominò et volese che fusse et instituì l'Ill.mo Sig.r Guido Baldo suo dilettissimo consorte in vita sua solamente et dopo la morte di esso S.r Guido Baldo instituì et sustituì in tutta la sua eredità eredi universali et instituì egualmente li S.ri Francesco Maria, S.r Carlo, S.r Alessandro, S.r Oratio, S.r Ugucione, S. Onofrio, et S. Giovanni suoi figli legatissimi et naturali nati di lei, et di detto S.r Guido Baldo. Et perché appresso // di lei ha qualche merito più degl'altri il S.r Oratio vuole et ordinò che oltre la parte ch'egli doverà averse dell'eredità di lei egualmente con gl'altri figli di essa S.ra et fratelli di lui sia propria et libera di esso S.r Oratio la possessione di Soria in Corte di Pesaro di esso S.ra Testatrice con ogni ragione miglioramento acquisto et accrescimento che vi sarà che ch'ella in quella avesse acquistato per qualsivoglia titolo et modo nell'avenire, nella qual possessione et beni di Soria instituì et sustituì il detto S.r Oratio dopo la morte del detto S.r Guido Baldo et al S.r Oratio la lasciò per ragion di prelegato et in ogni altro miglior modo. Et perché la detta S.ra testatrice vuole e desidera che li detti suoi Sig.ri figli et eredi come di sopra abbino da vivere et procedere sempre conforme alle qualità e grado loro, però ordinò volse et commandò che se alcuno delli detti suoi Sig.ri figliuoli farà mai cosa inconveniente e indegna, grave et enorme di sé verso il Sig.r Guido Baldo, o verso li suoi fratelli che in tal caso quello decada et s'intenda subito decaduto dalla sua eredità e la parte sua s'intenda subito applicata e fatta propria de gl'altri suoi fratelli e tutto questo fece e commandò non perché ella difidi de suoi figli ma per la gelosia ch'ha et deve avere la madre che i figli si trattino bene insieme et trattano bene verso il padre al quale sono tanto ubligati e devano tanta riverenza.
//
Et questa disse essere la sua ultima volontà et ultimo testamento, qual volse valere per ragion di nuncupativo testamento; codicillo donatione per causa della morte et in ogni altro modo migliore; cassando et annullando ogni altra ultima volontà et volendo che questa si preferisca a tutti.
Fatto et ordinato da detta S.ra Testatrice il presente testamento scritto in perpetua memoria e probatione ** del vero e publicato da me notaio d'ordine di Lei nel giorno, anno, pont. et inditione sudette nella chesa de' Rev. Padri Cappuccini di Pesaro fuori di Porta del Ponte nel Monte di S. Bartolo.
Presenti i molto Rev Padri Cappuccini ora residenti in detto Convento, il Padre Guardiano Fra' Giusto da San Giusto, 2 il Padre Fra' Battista da Bologna, 3 il Padre Fra Gostanzo Bergamasco, 4 il Padre Fra Paolo da Pesaro, 5 il Padre Fra Nicolò da Spalatro, 6 il Padre Fra' Corada Offida, 7 et il Padre Frat'Alessio da Monte Cicardo testimoni chiamati con propria bocca da detta Sig.ra et pregati.

Guidobaldo's last of January 4th 1607[1]

Al nome santissimo di Dio, Amen; negli anni dalla salutifera natività di Giesù Christo suo figliolo et nostro Redentore 1607; ind.ne quinta, sedente Paolo quinto Santissimo per divina providenza Pontefice ottimo massimo et a dì 4 di genaio.
Racordevole l'Illustrissimo Sig.re Guidobaldo dal Monte di avere testato sotto rogito di me Notaio inanti a dì primo luglio 1597 et anco del modo che testò e non volendo morire con detto testamento, egli sano della mente, inteletto, vedere, et udire ancorché indisposto et infermo del corpo rivocò et annullò detto testamento et il presente nuncupativo testamento chiamato dalle leggi senza scritti dispose de' suoi beni come segue:
Prima con ogni umiltà di cuore raccomandò l'anima sua all'infinita misericordia d'Iddio[2] alla Vergine Santissima et alli Avocati suoi[3] senza alcuna pompa funerale // nella chiesa dove si celebra messa del Convento del Santissimo Corpo di Christo.
Alla Chiesa Catedrale Ospetale dell'Unione al porto, et Monte della Pi<e>tà di Pesaro [passo] oltre il mare et cose incerte mal tolte lasciò per una sol volta a ciascuno di essi luoghi bolognini dieci.
Gravò gl'Illustrissimi Signori suoi eredi a spendere scudi dodici in far celebrare tante messe agli altari privilegiati per l'anima sua morto ch'egli sarà.
Alla Ill.ma Sig.ra Felice della Rovere sua dilettissima, amorevolissima consorte lasciò per legato oltre i mobili di lei tutto quel mobile et masaritie che a lei massimamente piace e per potere vivere conforme alla sua [commodità], et anco l'abitatione in casa di lui in un *** che a lei piacerà qui in Pesaro sino ch'ella viverà, ma quanto al mobile et masaretie glilo lasciò libero et assoluto.
Liberò la medesima Illustrissima Sig.ra sua consorte da ogni molestia che a lei si potesse dare da Ss.ri eredi o da altri[4] qualsivoglia [onere] // d'amministratione de' beni et cose sue et di lei ch'ella avesse fatto et facesse nell'avenire sino alla morte di lui; et se ne fusse molestata o mandata debitrice in qualsivoglia somma et cose, egli adesso per allora et e converso il tutto le lasciò per ragione di legato.
Alla medesima Illustrissima Signora Felice per restitutione di quella parte di dote pagata da lei, o altri per lei, sino al presente giorno et per ragione di legato, lasciò il podere tutto con tutte le sue pertinenze, ragioni et qualità di posto nella Corte di Scapezzano per tanto quanto è; e per il medesimo prezzo che fu comperato et con tutti gli acquisti et compre fatte dopo et incorporate a detto podere, et con tutti i miglioramenti e nel modo in che si trova. Et anco per dette ragioni di restutitione et legato le lasciò la possessione in Corte di Pesaro in quello di Soria con tutte le sue pertinenze, acquisti et bonificamenti, e nel modo et stato in che si trovano. Et se più valessero di quello che furono comprati tai beni gli lo lasciò per

[1] Cf. ASP, fondo Notarile, Vasconi Giovanni, busta 1732/1746, fols. 1v-5r.
[2] *post* Iddio *aliquot verba legi nequeunt cum pars folii desit*
[3] *post* suoi *aliquot verba legi nequeunt cum pars folii desit*
[4] *post* altri *unum verbum legi nequit cum pars folii desit*

legato; non volendo che in sconto della detta dote se impati a lei se non i prezzi a che furono comprati, // e non i miglioramenti fatti dopo né l'acrescimento di prezzo che per corso di tempo fusse servito; volendo che il censo imposto sopra tai beni per la sorte di scudi mille a favore del S.r Conte Carlo Gabrielle in Roma o d'altro si paghi dalli eredi Illustrissimi di lui.
Ordinò che si per le pretensioni che si hanno contro l'Illustrissimo Sig.r Federico suo fratello si recuperarà cosa alcuna [siatingua col d.da ricuperarsi detto] censo.
Dechiarò et gravò che chi de' Signori suoi figli avesse avuto mobile lo debba comunicare per rata eguale con gli altri Signori figli suoi.
Agli Illustrissimi Signori Oratio, Uguccione et Giovanni lasciò per prelegato tutti i suoi libri di mattematica, cassettini, stucci, compassi, ferri, bossole, modelli, instrumenti et disegni stampati e non stampati con ogn'altra cosa pertinente alla professione mattematica.
Al Ill.mo Sig.r Alessandro suo figlio lasciò i libri di legge, theologia et filosofia. Et gli altri siano communi tra tutti li Signori suoi figli.
Dichiarò di avere operato il magnifico m.r Giovan Batista Gambini non solo nell'uffitio di Mastro di Casa ma anco in tutte le liti sue ventilate per[1] // anni et di buon numero et però sapere anco ch'egli non ha potuto aggiongere et perfettionare i conti et la scrittura per il che vuolse ch'egli abbia tempo di due anni a render conto et a dar fuori i libri della sua amminestratione dal dì della sua morte.
In tutti gli altri suoi beni proprii [enfeteotici], ragioni et attioni presenti e futuri instituì e nominò con la propria sua bocca gli Ill.mi Signori Francesco Maria, Alessandro, Oratio[2], Uguccione, Onofrio et Giovanni, amatissimi et carissimi suoi figlii egualmente; gravandogli egualmente a pagare alle Ill.me sue figliole Francesca e Chiara, monache nel sudetto convento, un scudo per una al mese finché viveranno corporalmente; ma se una morisse non accresca alla sopravivente la parte della moriente, pregando instantemente i Superiori di esse per carità et amor di Dio a permettene ch'elleno possino godere, usare e spendere et ricevere per se istesse di legato nei bisogni loro che tanto più anco il convento verrà a solevarsi dal dispendio verso esse perché con tal speranza esso Sig.r Testatore le lasciò tal legato qual altramente non le averia lasciato come egli disse. Inoltre li gravò anco a vestirle da monache quando ne averannno bisogno. //
Et se uno o più de detti Signori soi figlioli in qualsivoglia età o tempo morirà o moriranno senza figlioli legettimi e naturali et nati del proprio corpo, instituì e sostituì gli altri figli di esso S.r Testatore sopraviventi equalmente o i figli di quegli che fussero morti in stirpe et non in capi, priviando espressamente a tal moriente et a tali morienti senza figli legitimi e naturali il poter disporre in vita et al tempo della morte di legettima debita per ragion di natura et di [trebeliancia]

[1] *post* per *unum verbum legi nequit cum pars folii desit*
[2] Oratio *correxi ex* Orati

acciò l'eredità[1] di lui si conservi tra i detti suoi figli e descendenti loro. Et a chi non acquietasse a questa dispositione lasciò solo per ragione de institutione la legittima debita per ragione di natura; et accettando l'eredità si intenda di averla accettata col sodetto fideicommisso.
Et questa deve essere l'ultima sua voluntà et ultimo testamento, commandando che vaglia come testamente noncupativo o almeno per via de' codicilli o di donatione per causa della morte in ogni modo megliore; cassando et annullando ogn'altro testamento et ultima voluntà et massime il sudetto di mano mia, volendo che questo si preferesca a tutti in ogni modo megliore. // Fatto et ordinato fu il presente testamento dal d. S.r Testatore giacente in letto, scritto, letto et publicato d'ordine suo da me Notaio a perpetua memoria e probatione del vero in Pesaro in casa di esso S.r Testatore apresso [le cui è] Signori Arditii et altri, nella contrada di S. Rocco, presenti li Reverendi Padri Fra Latantio Catrani da Perugia, frate Egidio Olivieri da Petritolo, Cappuccini, Don Baldo Gionti da Monte Cicardo, Ms. Valerio Feltrini da San Gustanzo, Ms. Aniballe Bondimandi et Ms. Flaminio Gianmartini da Monte Baroccio et Aldrovando Gini da Scotaneto testimonii conosciuti e con la propria bocca chiamati et pregati da esso S.r Testatore et adhibiti alle cose sudette.
Et[2] ego Iohannus Vasconus de [presentibus] rog.<iti>s libet [aliena manu m.i] fid. me [tum] distante et postea ressidente et aprobante.
In epi.<scopi> nomine assen<tis> die <anno> sud.o Pont. *** Paulo Ponti<fece> [quinto]. Ego Notarius Iohannus Vasconus fui vocatus per [partem] d.<icti> Ill.mi D<omini> G<uidi> Ubaldi // et ideo ad eum iacente in lecto ut s.<upra>. Et cum ad [sui putiarum] exliterim dixit mihi hac vel similia verba esistente ipso in statu <d. q. t.> et pretibus eisdem Reverendis prioribus Lact.<anti>o, Egidio[3], et Don Baldo et sedentibus ibi ad mensam.
Notate fra i miei rogiti ch'io lascio esse.<mpla>re del mio testamento l'Ill.mo et R.mo S. Card.le mio fratello et li raccomando [le persone tutte] di casa mia, oltre quelli che io principalmente desidero [rispetto] [da] S.A.S. per bontà sua. Et ideo ego Notarius sup.<erdictu>s [p.ta hu<nc> notam] rogatus.

[1] eredità *correxi ex* ereditatà
[2] Et ∼ rogatus *diversa manu*
[3] *ante* Egidio *del.* frate

I.7 After Guidobaldo's death

I.7.1 Letters in occasion of Guidobaldo's death

Guidobaldo's friends and interlocutors mourned for him, as the letter exposed in the present subsection testify.
The first document is a letter of Ludovico Agostini to Guidobaldo's wife, Felice Dal Monte.[1]

> Illustrissima Signora et Padrona mia osservandissima,
> se mai cavaliere illustre degno di emulationi, philosopho di theorica e di pratica degno di imittatione et famoso scientiato, sprezzatore per Christo di mondana ambitione, degno di esempio, infin qua non ho io saputo vedere un altro Guidobaldo del Monte, meritissimo consorte di V.S. Ill.ma, che bene di lui parlando con Dio potremmo, come di se stesso. Contò il propheta: *memento dicere David et omnes mansuetudinis eius*.[2] Che se questo religioso Signore non è volato diritto al cielo, potressimo al certo con Paolo a esclamare: *vana est fides nostra et vana pio Christo humilitas et afflicitio nostra*.[3]
> Signora mia, quanto V.S. più che gli altri ha, ne' penetrali di casa et di cuori, conosciuto i christiani progressi del Signore Guido Ubaldo et la speranza et fede che di lui ha sempre avuta dalla sua salute, tanto più che gl'altri, la ragione di consolar se stessi et noi altri di averlo, per qualche tempo di qua, smarito per andare, quando piacerà al Signore, a ritrovare in cielo et a goderlo per sempre fuori d'ogni stento di questa valle di lagrime dove con esso lui per infiniti casi di avversa fortuna, ha provato quanto siano quasi insopportabili le croci di questo mondo.
> Fra tanto V.S. con i Suoi generosi figli, godasi in ispirito quello che in senno più non può godere con l'una et con gl'altri, con questa mia breve, condolendomi che la loro prudenza di mistero non ha di lunga frase, starò pronto, aspettando che mi comandino con quella libertà et maggiore che far potevano, viviate il loro respetivamente consorte et padre et cordialissimo Signore et Padrone.
> Con che facendo fine in solido loro, bacio le mani col pregare al Signore, come sempre farò, per la comune salute di codesta illustrissima Casa. Dalla Rocca di Gradara, li X genaio 1607.
> Di V.S. Ill.ma
> Devot.mo ser.re
> Ludovico Augustini

[1] The letter is published in G. Montinaro, *L'epistolario di Ludovico Agostini. Riforma e utopia*, Firenze, Olschki, 2006. The annotations are his.

[2] Citation from Psalms, 130 (131), 1; cf. Montinaro, *L'epistolario di Ludovico Agostini*, cit.

[3] Cf. Letters to Corinth, I, 15, 17. Cf. Montinaro, *L'epistolario di Ludovico Agostini*, cit.

Interesting is also the following letter, from Omero Tortora to Pier Matteo Giordani:[1] it again underlines Pier Matteo's close scientific relation to Guidobaldo; it reveals on the other hand Cardinal dal Monte's mourning for his brother's death.

> Ill.re S.r mio oss.mo,
> mi pare che la perdita che abbiamo fatta del S.r Guidubaldo, che sia in cielo, sia comune a tutta la nostra città, la quale starà un pezzo a risotrarsi di questo danno; ma che sia poi particolare a V.S. et a me, avend-Ella perduta la conversatione delle lettere, et io un mio gran Signore il quale osservavo come il merito della sua virtù richiedeva.
> Il S.r Cardinale suo fratello n'ha sentito, e sente, molto travaglio. Si è ritirato per non ricever visite, et si sta ordinando le cose da scoraciro, perché S.S. Ill.ma vuole in concistorio comparire a ricevere le visite tutte in un tratto.
> Se a V.S. tornasse bene di condolersi in mio nome col S.r Federico <dal Monte> mi farebbe favore, sapend'io ch'egli avrà forsi caso di fuggir il travaglio di rispondere.
> Stiamo in grandissimi apparecchi di guerre; Dio faccia riconoscere i Vinitiani et espugni la loro ostinatione, perché altrimenti si può credere che Iddio abbia loro levato il cervello, non sapendosi trovare questa loro prudenza. Con che a V.S. bacio le mani, di Roma questo dì 13 gennaro 1607.
> Di V.S. Ill.re
> Serv.re aff.mo
> Omero Tortora
>
> Mi sono poi risoluto di scrivere al S.r Federico.

The following letter, sent by Alessandro dal Monte to Galileo,[2] constitutes another hint at the close relations between the Tuscan mathematician and the dal Monte family:

> Molto Ill.re Sig.r mio oss.mo,
> essendo che V.S. sia stato sempre di tanto affetto verso la persona del S.r Guidubaldo mio padre, non posso restare, ancorché con infinito mio dolore, avvisarLa di quanto s'è compiacciuta la Maestà di Dio rissolvere di lui: imperò sappia V.S. che egli per doi mesi passati ha sostenuto una infirmità nel letto tanto grave, che finalmente ieri l'altro, giorno dell'Epiphania, alle 20 ore et un quarto, se n'è passato da questa all'altra vita migliore, così avendo disposto la divina volontà.
>
> Pertanto, poiché in quella debbiamo quietarci, avendo Lei perduto chi amava tanto V.S., si compiaccia compatire al dolore del caso

[1] BOP, ms 415 fol. 57r.
[2] Cf. BNCF, mss. Gal. P.1 T. VI, fol. 167r; published in G. Galilei, *Opere*, cit., vol. X.

successo e ricevere me con gl'altri miei fratelli, che in suo loco siamo succeduti, per Suoi servitori d'affetti, se non d'effetti, che pareggino e i meriti di V.S. e lo amore con che L'osservava il suddetto Sig.r nostro Padre, che Dio se l'abbia seco in cielo.
E con tale affetto me Le offero a Suoi commani, con baciarLi le mani.
Di Pesaro, il dì 8 di gennaio 1607.
Di V.S. molto Ill.re
Aff.mo Ser.re
Alessandro dal Monte

I.7.2 The fall of the dal Monte house

After Guidobaldo's death, his first born son Francesco Maria (II) dal Monte became Count, a year later he was even made Marquis of Monte Baroccio; further, the "payroll" of the court shows him as a member of the Duke's "famiglia":[1] these are signs that the dal Monte family was generally reintegrated in Francesco Maria II della Rovere's grace. Yet, Guidobaldo's son did not live long enough to re-establish the family's outstanding position in the Duchy: he died already in 1619.
Afterwards, the difficulties to control the young heir and new Marquis of Monte Baroccio, Ranieri (II) grew more and more: Guidobaldo's brother, the in the meantime 71-year-old Cardinal dal Monte, tried to keep down the situation, as his letter to Giulio Giordani shows:[2]

Ill.re Sig.r
La Marchesa mia nipote ha tanta voglia di venir qua che per quello che può dipendere da me io vorrei consolarla. Et per o desidero con ogni confidenza che V.S. mi avvisi in che modo potrebbe ottenersi da S.A. l'effetto di questo suo desiderio, et insieme se si contentasse che l'istessa Marchesa menasse seco il figliolo <Ranieri (II)> per due o tre mesi.
Aspetto risposta con la confidenza che ho sempre avuta nela Sua cortesia. Et La saluto di core. Di Roma li 13 di giugno 1620.
Di V.S. come fratello amor.mo
Il Card.le dal Monte

As the following letter shows,[3] Duke Francesco Maria II does not seem to have agreed with the Cardinal's idea to let come to Rome Ippolita Savelli and Ranieri (II). On the contrary, her approach of the Duke is an alarming document that

[1] Cf. Appendix I, I.4.4.
[2] Cf. BOP, ms 426, fol. 141r.
[3] Cf. BOP, ms 375, fol.142r/v.

she felt to lose any control over the 10-year old boy, only one year after Francesco Maria (II)'s death:

> Ser.mo Sig.re et Padrone mio singolare ,
> le male qualità de mio figlio <Ranieri (II)> mi tengono straordinariamente afflitta e non avendoli io mancato de' ricurdi e correttione e botte secondo che ha apportato l'occasione vedendo non giovarmi niente anzi intendo tutti maggiore e nove stravaganze, ho preso per espediente riccorrere all favor di V.A. Ser.ma; che sì come con tanta benignità Li fu tanto grata, vogli novo farli una gagliarda correttione nella maniera che la Sua molta prudentia giudicasse necessaria; che perciò potria forse chiamare il mastro e intender da lui menutamente in quello [deffatto] essendo molti che non si ponno mettere in carta.
> V.S. Ser.ma farria gran carità a me obligata maggiormente [se in un incontro] possano [arricare] le mie obbligazione; perché non mutando vivere con questo [meschero] ho il caso per spedito e sarò necessitata contra mia voglia abbandonarlo, non temendomi niente. Ma spero che un cenno di V.A. Ser.ma mediante la [decina grandemente] apportarà la consolazione che bramo.
> Intanto La suplico a [compatirme] se l'affetto materno mi ha fato ardire *** prottetione di V.A. Ser.ma alla quale mi inchino e [riv.mente] bacio la mano. Da Monte Baroccio alli 10 di settembre 1620.
> Di V.A. Ser.ma
> Devotissima et umilissima serva e suddita
> La Marchesa di Monte Baroccio

I.7.3 The posthumous editions of Guidobaldo's works

After Guidobaldo's death, his former interlocutors Pier Matteo Giordani, Bernardino Baldi, Cesare Benedetti (and so on) tried, under the organisation of Orazio dal Monte, to publish his writings which had remained unpublished. The following letter from Omero Tortora to Pier Matteo Giordani testifies that they searched the means to print his works. Apparently they approached also the Cardinal dal Monte, who, though, had already spent too much money in other affairs:[1]

> M.to Ill.re S.r mio oss.mo,
> scrivo al S.r Oratio del Monte in risposta del negotio scrittomi da S.S. e da V.S. Io per la qualità della materia dubitai di poter far poco profitto, nondimeno concorrendovi [così] gran rispetto come quello è di aver a dar in luce cose di quel Sig.r <Guidobaldo> mi fece sperare

[1] Cf. BOP, ms 415, fol. 62r/v.

di poter superare le difficoltà ch'io so avere nella materia pecuniaria, la quale si [sta] sempre stringendo più. Come io scrivò al S.r Oratio, il S.r Card.le suo zio si è scusato assai [sopra molte] spese fatte a Napoli, et in una fabrica qua in Roma, e mi condusse il testimonio che fu il suo maggiordomo, ne valse il dire a S.S. Ill.re che io avrei fatto di modo ch'Ella sarebbe assicurato del danaro che prestasse e, per dirla a V.S., volevo io far questa sicurtà, parendomi ch'all'osservanza che io devo alla memoria del S.r Guid'Ubaldo, non [possar] far cosa che mi sodisfaccia.
Ma insomma, non cavai altro da S.S. Ill.re se non che rimarrà sodisfattissimo che si stampi ciò che vi è di quel Sig.re e che se non fosse tanta la somma, o se si aspettasse ch'egli avesse miglior comodità, che non mancarebbe [soldi]. Ma io vedo che sarebbono cose lunghe e che S.S. Ill.ma non preme tanto quanto sarebbe il bisogno e disiderio di tutti e perciò sarà necessario che si vada per altra strada, et io che credo che il danaro che si spenderà si ritrarrà con utilità, voglio anche sperare che non saranno lasciate sepolte le cose che sono rimaste del S.r Guid'ubaldo, sì per l'onore che ne riceverà la casa sua, come per l'utilità che ne riceverà il mondo.
Insomma, le cose passano così e credo anche che a V.S. non [pareria] tanto strano, con <che> Le bacio le mani e L'assicuro ch'io Le sono il medesimo servitore di sempre, e che non ho il maggior dispiacere del vedermi così poco fortunato a non arrivar mai a poterLa servire come necessario. (...) di Roma questo dì 21 maggio 1608
Di V.S. m.to Ill.re

Il S.r Card.e propose il partito che so che tutti le Ss.rie vostre sanno ch'è il fare partito collo stampatore, quando non si possa far altrimente e credo che lo farebbono volentieri, perché ormai le opere del S.r Guid'ubaldo hanno il creditò che bisogna.

Aff.mo ser.re con tutta l'anima
Omero Tortora

The fact that the Cardinal dal Monte did not want, or was not able, to sponsor the publication of Guidobaldo's manuscripts probably led to the situation that Orazio and his collaborators were constraint to make a contract with an editor of the *Problematum astronomicorum Libri septem* which turned out to be of scarce quality.
The next letter documents the works of Orazio, Pier Matteo Giordani and the Cardinal dal Monte for Guidobaldo's astronomical treatise. It reveals that it was P.M. Giordani who had chosen the frontispiece of the book and its motto; interestingly, it further suggests he had access to the figures of the *Mechanicorum Liber*. In the meantime, Orazio and his collaborators had chosen G.B. Ciotto and

B. Iunta at Venice as editors:[1]

> Molto Ill.re S. mio oss.mo,
> la sera avanti la mia partita di Venetia ci accordassimo il Ciotto et me per lo stampare i *Problemi Astronomici*, et egli mi ricercò con molta instanza di sollecitare a mandarli le figure e che si facesse ottenere la licenza da superiori per stamparlo perché egli desiderava mandarne in Alemagna da 4<00> o 500 per la fiera di Francfort, sperando spacciarli subito. Et anco restassimo in apuntamento che facesse un saggio dei carateri così diversi come del foglio e che l'Ill.mo S. Giustiniani lo mandasse a V.S. acciò con il suo buon parere dicesse quello di più o di meno che ci vorria, e mi diceva il stampatore che doi caratteri bastavano, senza i maiuscoli perché con quello che scrive la propositione si può scrivere il corolario poiché ** ai caratteri tondi ci va la dichiarattione di quello che è se è propositione o corolario. Così si saria fatto più [testo] e con [manco] pericolo d'errare, al ché a V.S. mi reportai.
> Quando V.S. et me incontrassimo le figure di questi *Problemi Astronomici* non trovassimo difficoltà, se non in una che è questa la precisa nota, sicché V.S. li dia un'occhiata et se ha inviato la carta delle figure a Venetia lo averta là.
> Nel terzo libro nelle figure 41, 42, 43 che sono intagliate manca il piano OP[2], tutte l'altre stavano benissime.
> Ho scritto al S. Card.e circa la dedicatoria, sentirò quello che risponde.
> Il Giotto vole stampare di novo le *Mecaniche*, che per gratia V.S. favorisca vedere se le figure sono tutte che le servirà per un fastidioso trattenimento.
> V.S. pensi e poi finisca il pensiero per la figura da mettersi avanti il libro che il fare l'ottava sfera o dove sono le 48 imagini mi piace però li faccia il motto, secondo il Suo gusto. Le ** devo servire V.S., Ella sa quanto sono obligato a servirLa, sicché [se per] mi commandi, et ** il S.r Giulio e S.r Camillo. Il S.r Giovanni mio frattello et io Le bacio molto affezionatamente le mani. Di Crema li 9 Luglio 1608
> Di V.S. M.to Ill.re
> Aff.mo Serv.re Di Core
> Oratio dal Monte

The following letter turn to the topic of the publication efforts for the *Astronomicorum Problematum Libri septem*: it reveals again Pier Matteo's crucial role in the editing process, since he was asked by Orazio to write a kind of introduction.

[1] Cf. BOP, ms 412 fol. 37r/v; July 9th 1608; Orazio dal Monte to Pier Matteo Giordani.
[2] Nel terzo ∼ piano OP: *sublin.*

Remarkable is the confidence that Orazio had in Pier Matteo Giordani's mathematical talent.
Besides, the letter hints also at the *De horologii solaris descriptione in aqua refractis*.[1] Further, this time also Giovanni, Uguccione and Alessandro dal Monte are nominated as involved in the publication enterprise, as well as Guidobaldo's philosophical interlocutor Cesare Benedetti:[2]

> Molto Ill.re S. mio oss.mo,
> se, quando V.S. mi propose la osservattione che Le parea bene di mostrare prima il modo di fare gl'orologgi nei vasi per far poi i <orologgi a raggi> refratti nella Sua cortessissima delli 13 settembre, avesse notato quello ch'ora mi dice nella presente <del> 2 ottobre non vi avrei fatto scrupolo, perché ora La mi dice, che il modo da descriverli ne' vasi non è così ordinato, massime nel modo che facea quel buon Sig.re <Guidobaldo dal Monte>.
> Il scrupolo mio nasceva che questo che mio Padre <di> buona memoria non voleva dire mai cosa d'altri, lasciandone il costume al Clavio e molti, ma tutto volea fosse suo. Quando anco il modo da descriverli ne' vasi non fosse proprio suo, per essere cosa che non tutti sanno, sento con V.S. esser necessarissima la dichiarattione. Onde laudo sommamente il prudentissimo Suo parere, non mai fallace in queste esquisetezze sì come in ogni cosa, io che per zelo di mio Padre suo amicissimo avrà risguardo al buono.
> Faccilo senz'altro, se così Le pare o se non trova cosa in contrario, la dichiarattione prima degl'orologgi nei vasi e poi dicasi del refratto et ** non potria piacere l'opusculo con la mancanza di questo, poiché bisognarebbe insegnare un'operattione ad una, ma con questo patto che [colui] la sapesse mezza prima et uno che mezza ne sapesse non potria godere della invenzione de' refratti.
> Senza dunque sentire il parere del S. Abb. Guastalla <Bernardino Baldi> che senza dubbio non discordarà, V.S. per suo trattenimento potria mettere mano a far la dichiarattione di questi modi primi.
> Mi mostrò il S.r [Fed. Mem.] quella della semisfera che se occorrerà la mandarò a V.S. ma non mi [scrivere] già del altre concave sole sicché per l'una e per l'altra Lei non resti pensare alla costruttione e quando mai Lei sapesse che fossero d'altri notarle, e notare come si costuma in margine il comp.re perché tuttavia più mi confermo nel parere che l'opuscolo patirebbe senza esse. Altro che noi saremo scusati potendoci pigliare questa licenza di dire quello che non avrebbe detto il Sig.r perché egli era in quella eminenza che si sa.
> Non so poi se avremo fatto il S.r Uguccione, s. Giovanni miei fratelli

[1] In regard, cf. also the letters of Muzio Oddi exposed below.
[2] Cf. BOP, ms 412 fols. 41r-42v; Orazio dal Monte to Pier Matteo Giordani.

et io al [uto] di questi paesi perché qua si dice "Legge (o Parte) Venetiana non dura una stemana". Restammo in apuntamento che dello ** di Casa delle cose mattemattiche nessuno di noi tre eredi [potria] cavar minima cosa, senza prima dire agl'altri il [gusto] suo overo farne nota; il S.r Uguccione è stato l'ultimo a partire, egli deve rendere conto di questo opuscolo e non posso credere che se l'ha levato non ne avria fatto nota, nel che amo non restare sodisfatto perché era scritto di propria mano del Guidobaldo che se ne vole[va] una copia era meno male.

V.S. dunque vi faccia ogni diligenza e quando non sia così ne scriva due [righe a] ** Uguccione che Glene dia aviso, e La prego metterci ogni spirito, perché l'orologgio refratto mi pare una bella curiosità ancorché sia una prattica.

Non dubito che ciò che venirà dalla mano di V.S. sarò cosa ** per mettere in testa de' *Problemi Astronomici* senza che Lei mi voglia addurre testimonii che il schizzo fatto sin'ora secondo il Suo volere sia piaciuto a Monsignor <Cesare Benedetti> ** Vescovo et al S.r Alessandro mio fratello che a me basta che venghi da Lei che per la domestica intrinsich[ezza] e per le dottissime qualità con che trattava con mio [Padre le figure] come così fatte da esso Signore.

Ma dalla stampa che si ** il S.r Giustiniano non me ne parla molto, se non che già aspettav[a] la carta da Salò et pure ne ho dato de' ricordi al Ciotto e [La], se viene in taglio a V.S. nel mandare quello schizzo, potrà dire una parola perché questo Ciotto ci vole trattare troppo a suo modo.

Mandai al S.r Giulio Suo fratello una risposta di certo aviso da Lignago. Credo sii capitata in mano di esso S.r, ma perché non mi favorisce commandarme altro ne dubito: piacerà a V.S. con l'occasione di recordarmeli obbligatissimo e baciarli affettuosamente le mani a mio nome, di dirglene una parola e che non mi faccia torto di privarmi delle occasioni di doverlo servire. Mi conservi V.S. in Sua gratia per mio capitale grandissimo e mi commandi e Le bacio le mandi, pregandoLe ogni bene. Di Crema li 29 ottobre 1608.

Di V.S. molto Ill.re

Aff.mo Ser.re di core

Oratio dal Monte

Ireneo Affò, in his *Vita di Monsignore Bernardino Baldi da Urbino*,[1] reports another letter by Orazio dal Monte to Baldi, written on November 5rd 1608, i.e. few days after the precedent one. It contains interesting information both on the works on the *Problematum astronomicorum Libri septem* and on Orazio's project to publish, afterwards, also the other remaining manuscripts of his father.

[1] I. Affò, *La Vita di Monsignore Bernardino Baldi*, Parma, Carmignani, 1783, pp. 222-23.

As Affò writes, these should have been introduced by Baldi's *Vita of Guidobaldo*.[1]

> Il Signor Piermatteo Giordano nostro pensa mandarmi certi opuscoli di mio Padre, acciò V.S. lor dia un'occhiata, perché penso metter fuori anco questi, dopo sarà finita la stampa presente degli *Astronomici Problemi*, dietro a' quali si attende continuamente, governandomi con il Suo prudentissimo parere, che lodo esser meglio metter fuori questi *Problemi* <*Astronomici*> e poi la *Coclea* e gli opuscoli, e se altro vi resti di quel viruoso Signore.

It is remarkable that the manuscripts were in possess of Pier Matteo Giordani – it seems unclear if temporarily or permanently. This again emphasises the latter's close affinity to Guidobaldo and his work.
At the time of the following letter, the *Problematum astronomicorum Libri septem* had already been printed. Orazio dal Monte complains to P.M. Giordani about the many errors. Further, it is another testimony of the existence of a circle of mathematically interested scholars around Guidobaldo ("gl'amici virtuosi di mio Padre et i miei, che sentivano gusto delle Mattematiche sono morti."):[2]

> Molto Ill.re S.r mio oss.mo,
> mi pareria far torto a V.S. con dirLe che Li mando uno de' volumi de *Problemi Astronomici* di mio Padre <di> beata memoria per obligo di farne parte a V.S. perché Lei è [molto Padrone] del proprio originale, ma Glene mando per l'obligo che devo alla mia servitù. Siane lodato Dio che pure uscì fuori, et gl'errori che vi sarranno vorrei fossero [condonati] alla absenza mia che non vi ho potuto attendere quanto si dovea.
> Ne mando 20 copie al S.r Giovanni da distribuirsi costà, et ne ho mandato a Roma et in questo [m'è] convenuto essere parco perché ne ho avuto pochi volumi, oltre che non avrei anco saputo a chi bene impiegarli, perché gl'amici virtuosi di mio Padre et i miei, che sentivano gusto delle Mattematiche sono [morti]. Piacerà Dio che l'opera aquisti credito come spero.
> Quello che mando al S.r Abbate di Guastalla scrivo al S.r Giovanni che pigli partito [da] Lei di recapitarglene e con affetto Le bacio le mani. Di Crema li 15 luglio <160>9.
> Di V.S. m.to Ill.re

[1] Affò introduces this letter, reported in the context of his hint to Baldi's *Vita of Guidobaldo* that still existed at his time at the Albani-Library, with the following words: "Il Signor Orazio dal Monte, a 5 di novembre del 1608, così scrisse al nostro Baldi." After its citation, he comments: "Fu dunque allora che desiderando di far accompagnar ad alcuna di dette opere la *Vita di Guidubaldo*, già tanto suo amico, diessi a distenderla in latino. Non la ridusse però all'ultima perfezione."

[2] Cf. BOP, ms 412, fol. 47r/v; July 25th 1609.

Aff.mo ser.re di core
Oratio dal Monte

The following letter documents that Orazio had contacted also Galileo in order to ask advice about the publication: he seems to have answered to the former to have "learned many new things" from the *Problematum Astronomicorum Libri septem* and to "appreciate it very much". Further, the letter deals also with the publication of the *Cochlea*: the "Paolo [Servita]", cited in this context, might be Paolo Sarpi who consequently would seem – if the reading turns out to be correct – involved in the publication of the *Cochlea* as well.[1]

Molto Ill.re S.r mio oss.mo
Tarda molto il S.r Giustiniano a mandare a Pesaro i libri de' *Problemi* <*Astronomici*> che V.S. può esser certa che io abbia ordinato che vi [sia] il Suo et mi sarà caro sentirne l'arrivo, ma [non sto] pensando ch'è tardi, perché mi scrisse ch'avea desiderio di far mutare quel foglio che riuscì così male, se bene già avea dato al Doge il suo. Et anco il S.r G. Galileo ha avuto il suo et mi risponde che lodarrebbe l'opera quando a me non fosse noto l'autore, et scusandomi io che lo stampare in Venetia opere mattematiche sogliono venire scorrette, egli dice non averci trovata cosa notabilissima se non in quanto alla politia dell'opera et mi afferma avervi conosciuto molta novità et lo stima assai.
Prego V.S. incontrare le figure della *Coclea* con il libro perché ho trovato un altro partito che se mi posso promettere meglio del correttore sì come sperò, poiché quel tal D. Paolo [Servita] (famoso per le cose passate) mi si offerisse prontamente, anzi si duole non avermi conosciuto prima che m'avrebbe servito in questo; et lo stampatore che non sarà il Ciotti me lo permette in doi mesi, essendo cosa di [50] fogli come io li dissi. Però V.S. mi favorisca per gratia fare questo incontro e dell'opera e delle figure che poi aviserò V.S. quello si potrà fare.
Mi par bene avisare a V.S. come non ho mai ricevuto da quel Pasquino da Casteldurante il mio istrumento <di> Galileo, carissimo a me sopra modo, perché vi ho accomodato il gusto e l'uso e perché rarissimi se ne trovano. Io ne ho qualche travaglio che sia pericolato, onde La supplico ricuperarlo et inviarlo al S.r Giustiniani che me lo mandarà securissimamente. Et a V.S. con i Suoi affettuosamente bacio le mani. Di Crema li 26 agosto 1609.
Di V.S. molto Ill.re
Aff.mo ser.re di core
Oratio dal Monte

[1] Cf. BOP, ms 412 fol. 49r/v; Orazio dal Monte to Pier Matteo Giordani; August 26th 1609.

The following letter suggests that Pier Matteo Giordani had chosen also the frontispiece of the *Cochlea* and the motto. Further, it is another testimony of Baldi's fundamental involvement in the publication process ("Poiché Monsig. Abb. Baldi vedrà gl'opuscoli et il parere di esso S.re ne darà la vera scorta, il quale con quello di V.S. farranno che l'opere di mio Padre comparischino come devono."):[1]

> Molto Ill.re S.r mio oss.mo,
> se bene dovrei credere che V.S. a quest'ora avrà visto l'*Avviso Astronomico* del S.r G. Galileo, nondimeno avisandomi V.S. per ancora non averlo veduto, Glene mando uno quale ho inviato a Venetia al S.r Giustiniano che lo mandarà a V.S. et La prego poi farmi parte del Suo gusto.
> Mi piace assai assai il motto della *Coclea* et l'impresa, né è da credere si possi trovar meglio per tale bisogno. Et circa la impressione di essa la necessità ci farà lasciar stare Venetia perché il S.r Giustiniano che favoriva della cura deve venire rettore in una [fortezza] qui vicino, et io non fidarei l'impresa in mano di nessuno. Et anco il mal esito (et la grandissima ignoranza de' stampatori nelle cose matematiche) delli *Problemi Astronomici* mi ammonisce andare cauto et si servarà tutto per fare una sola fattura.
> Poiché Monsig. Abb. Baldi vedrà gl'opuscoli et il parere di esso S.re ne darà la vera scorta, il quale con quello di V.S. farranno che l'opere di mio Padre comparischino come devono.
> A V.S. bacio le mani et me Li ricordo obbligatissimo et il simile a quei Ss.ri Suoi. Di Crema li 16 giugno 1610.
> Di V.S. m.to Ill.re
> Aff. ser.re di core
> Oratio dal Monte

The same day, June 16th 1610, Orazio wrote also to Galileo, friend and collaborator of his father and probably his own teacher of mathematics. It contains a highly interesting list of Guidobaldo's unpublished manuscripts:[2]

> Ill.re et ecc.mo Sig.r mio oss.mo
> V.S. Ecc.ma dà frequente dimostrattioni al mondo della vivacità et felicità del Suo bellissimo intelletto, et poi non lascia occasione di darle a me della singolar Sua cortesia. Onde troppo cumolo fanno seco tant'oblighi miei, et quanto vaglio, Li rendo gratie del Suo *Aviso Astronomico*.
> L'inventione del'occhiale è cosa veramente di grandissimo gusto, né mi posso persuadere che olandesi o altri ingegni barbari vi siano a parte.

[1] Cf. BOP, ms 412 fol. 52r/v; June 16th 1610.

[2] Cf. BNCF, mss Gal 88, fol. 136r. We have revisited, recurring to the original, the transcription contained in G. Galilei, *Opere*, vol. X.

Ma questa, d'aver scoperto quattro pianeti di più, è cosa maravigliosa, et simile allo scoprimento d'un mondo novo; et V.S. Ecc.ma potrà con molta raggione gareggiar di gloria con il Colombo, nonché avantaggiare il Montereggio: et io, che professo portarLe particolare affetto, godo in estremo che il Suo nome cresca con il Suo molto merito.
Aspettamo qualcosa sopra l'istromento Suo geometrico, perché nelli libretti V.S. Ecc.ma promette un giorno far vedere cose di piú.
Io mi ritrovo in essere alcune opere di mio Padre b.m., che le vorrei dar fuori. Ma li stampatori di Venetia mi hanno tradito troppo con le scorrettioni ne' *Problemi Astronomici*. Se fosse possibile che in Padova io fossi servito di buon correttore, io le darei fuori volentieri, perché son consigliato et importunato farlo, et le opere son curiose: la *Cochlea che inalza l'aqua*, divisa in quattro libri; opuscoli: *In Quintum <Librum Euclidi Commentarius>*, *De Motu Terrae*, *De Horologiis radiis in aqua refractis*, *In nono opere Scoti*, *De proportione composita*, et la fabrica di alcuni istromenti ritrovati da lui; delle quali tutte cose vi sono le figure intagliate.
Io prego V.S. Ecc.ma avisarmi come potrei fare. E per non tediarLa più Le bacio le mani. Di Crema, li 16 giugno 1610.
Di V.S. Ill.re et Ecc.ma
Aff.mo ser.re di core
Oratio del Monte

This list of Guidobaldo's extant and unpublished works is confirmed by still another source: BOP, ms 198 reports on fol. 136v a list of Guidobaldo's published and unpublished works (cf. figure I.5) – apparently it has been composed between 1609 (the year of the edition of *Astronomicorum Problematum Libri septem*) and 1615, since the *Cochlea* is described as still a manuscript.

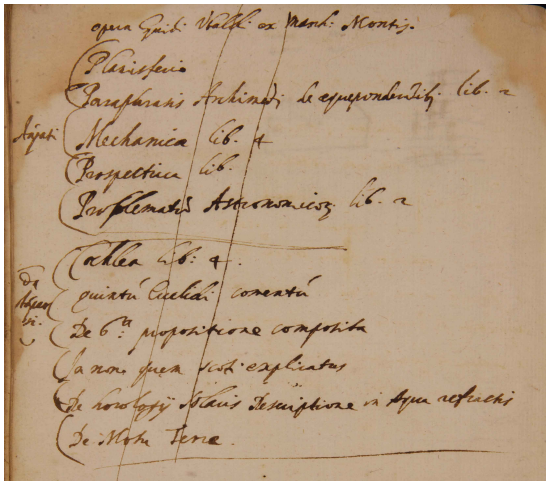

Figure I.5: The *verso* of folio 136 in BOP, ms 198: the list of Guidobaldo's printed, and partly still unedited works.

The following works are characterised as "printed" ("*stampati*"): *Planisferio*, *Paraphrasis Archimedi de Aequeponderantibus Libri 2*, *Mechanica Lib. 4*, *Prospectiva lib.*, *Problematum Astronomicorum lib. 2*; as "to be printed" in contrast: *Cochlea lib.4*, *Quintum Euclidi Comentum*, *De sexta propositione composita*, *In nono quem Scoti explicatus*, *De horologii solaris descriptione in aqua refractis*, *De motu Terrae.*

The following letter is interesting because he documents Oddi's sceptical opinion about the publication enterprise; further, it interestingly mentions another manuscript of Guidobaldo that was not listed neither in Orazio's list in the letter to Galileo, nor in BOP, ms 198: a paraphrase on a passage about gnomonics of Gaius Julius Hyginus, which apparently G.V. Pinelli had asked Guidobaldo to write.[1]

> Molto Ill.re Sig.r mio oss.o,
> m'ha cavato V.S. con la Sua lettera un bel fastidio del capio per il dubbio che aveo che quei Sig.r del Monti consigliasi solamente coll'oppessione del proffondo sapere del Sig.r Guidobaldo di f. m. e col desiderio della gloria paterna, non presistessero in voler publicare i suoi opusculi; perché invero, sebene ci sono delle cose belle e buone, che forse il mondo l'aggradirebbe, non credo però che publicarle *ex professo* se li aggiongesse né onore né credito, essendo l'altre cose publicate da lui grave e di sogetti importanti, e di meglior peso di questi. Non dirò già che alcune cose si dovessero lasciar sepolte, ma le porei publicar con qualche inventione.
> Io nel mio libro degl'orologi ce n'inserisco due, e le mostrai al S.r Oratio l'anno passato che fu qui a Milano, e registrarò le parole precedenti parlando della linea meridiana, e sebene quello che pone Vit.o e molto facile e semplice, ho nondimeno con questa occasione voluto refferirne qui uno scritto da Higeno antico e famoso astronomo nei libri gnomonici, sì per la sottile et ingegnose inventione sua, esseguendo ciò mediante tre ombre prese in un giorno in qualsivoglia modo senz'alcun altra osservatione, come anco per essere quel luogo tanto consumato dalla moltitudine degl'anni, che malamente ne può trar construtto che non ha veduto l'espositione che vi fece l'Ill.mo Sig.r Guidobaldo de' Marchesi del Monte a richiesta del Sig. Pinelli[2] da Padova. //
> E' ben vero che in questo non ho osservato né l'ordine né le parole di detto Sig.r, solo mi son valso degl'argomenti per la dimostratione e dell'inventione di quei triangoli per addatarlo al mio proposito Dove poi tratto degl'orologi coneani dico così: "Non ho voluto per utile e gusto di coloro che si dilettano di queste gentilezze lasciarmi

[1] Cf. BOP, ms 413, fols. 7r-8v.
[2] *ante* Pinelli *spatium unius verbi rel.*

fuggir l'occasione che mi s'offerisce in proposito degl'orologi coneani orizontali, dìinserire in questo luogo un opusculo dell'Ill.mo Sig.r Guidobaldo de' Marchesi del Monte degl'orologi coi raggi rinfranti nell'acqua; inventione per mio credere così leggiadra, quant'altra trovata sino al giorno d'oggi in simile materia, e se bene per il mio bisogno sarebbe forse bastata l'ultima parte di esso, la brevità sua nondimeno m'ha in un certo modo fatto violenza a tradurre tutto. Del publicar col mio libro, questo opuscolo n'ebbi pensiero sino da [Loreto] e ne scrissi al Sig.r G.B.e fra le mie scritture vi sarà la risposta dove mi dava licenza. Ben è vero che per parere d'averlo fatto con qualche più stretta particolarità averei desiderato fingermi una letteruccia innanzi cola quale mi indirizzzasse detto opuscolo, acciò il mondo credesse che io avessi affetato detta occasione per ambizione mia d'essere stato disceplinato da detto Signor più che per altro, acciò che se il modo con ch'è stato trattato non paresse a qualcheduno della medesima [tacca] che sono l'atre opere; si lodasse lui nell'inventione et l'averlo publicato et l'averlo publicato sconsideratamente s'attribuisse a me. Detta lettera vorei se Lei l'approva che Lei stessa la facesse e direi così: all'improviso la desiderarei:

"Il Guidobaldo del Monte a Mutio suo.
Il gusto che si vidde prendere dall'orologio coi raggi rinfranti nell'aqua che io inventai per servire al Ser.mo nostro Padrone, mi ha mosso a inviarti quest'opusculo che ho scritto intorno ad esso, sperando che ti debba esser caro, e per la materia che tratta, e per l'affetione che ti porta, chi te lo dona, legilo, e se ti pare [conferimento] col Barocci e con gl'altri [instrutti] della patria et sta sano."

O cosa simile come parerà meglio a V.S. et a quei Sig.ri et al S.r Capi e quando si stimi bene ch'io inserisca detto opusculo nel mio libro, o per dir meglio, quando quei SS.ri non rivochino la licenza che mi diede il Sig.re. Arò poi bisogno del favore del Sig.r Camillo in tradurlo, diche ne parlai anco a Matto mio fratello che li ne facesse instanza perché desidero che sia approvato et revisto da V.S. e così vi caderebbe in conseguenza una acuratissima deligenza essendo di casa loro.
Averà finora saputo la morte improvvisa del Sig. Fabio Landriani (...)

The letter terminates without signature, which would have indicated its date. Yet, it can be supposed that it was written antecedently to the following one of August 8th 1612, from Oddi to Pier Matteo Giordani, which speaks again of sundials. Interestingly, Oddi claims not to have the intention to help Orazio in the solution of a (probably mathematical) problem:[1]

[1]Cf. BOP, ms 413, fols. 9r-10r.

Molto Ill. Sig.r mio e Padr. oss.mo,
Mio fratello un pezzo fa mi scrisse, che per molta diligenza usata in cercar la lettera che il S.r GU. di f.m. mi scrisse in Loreto intorno allo stampare il suo opusculo *Degl'Oroglogio coi raggi rinfranti nell'aqua* non l'avea potuta trovare; né io volendo cosa fuori del gusto di quei SS.ri suoi figli, aveo in tutto dismesso il pensiero che mi avea preso d'esso, non sapendomi imaginare qual cagione li potesse aver mossi a questa resistenza, e qual pregiuditio stimino che possa recare alla fama di quel Sig.re il stampare e ristampare in diverse lingue l'opre sue. Ne parlai col S.r Oratio quando fu a Milano, né ci fece difficoltà alcuna, solo che mi pregò ch'io ci aggiungesse "de' Marchesi del Monte" acciò non si credesse che fosse un altro, diverso da quello "ex Marchionibus Montis".
Hor se'l negotio si ripiglia col mezo di V.S. converrà che anco col mezo Suo si traduca, non avendo io né tempo né modo da farlo. Stamparò l'inventione della linea meridiana d'Hygenio fra pochi giorni in un opusculetto che scrissi degl'orologgi nelle superficie piane, senza chieder altra licenza alli suoi figli poich'io non refferisco le parole di detto Sig.re ma dico ben così: "E se bene quello posto da V.E. è molto facile e semplice, ho nondimeno voluto refferirne qui uno scritto da Higeno antico e famoso astronomo nei libri gnomatici, sì per la sottile et ingegnose inventione sua, esseguendo ciò mediante tre ombre prese in un giorno in qualsivolgia tempo senz'alcun'altra osservatione, com'anco per esser quel luogo tanto consumato dalla moltitudine degl'anni che malamente ne può trar construtto chi non ha veduto l'espositione che vi fece l'Ill.mo Sig.r Guidobaldo de' Marchesi del Monte a richiesta del Sig.r Gio. Vinc. Pinelli da Padova."
Quanto poi alla *Coclea* loderei molto che si stampasse, ma però sotto la cura di qualch'altra persona un poco più acurata che non fu quella dei *Problemi Astronomici*, né al S.r Oratio forse manceranno, né mancarà chi le procuri anco la risolutione del problema molto meglio di quello che saprei far io. Pure se me lo comandarà farò quanto posso per scrivere a quel benedetto Sig.r che sia in gloria. Non posso già negare che non mi rincresca molto il sentire certe cose sì fatte di questi SS.r d'intorno alle fatiche del lor Padre; che se non fosse V.S. che pure con la Sua autorità li tiene un poco a freno, Dio sa come starieno le cose[1].
Di me questi SS.ri, o per dir meglio una parte di loro[2] non hanno oppennione alcuna buona[3] e perciò mi conosco in tutto innabile a adarli

[1] Dio ∼ cose: *in interl.*
[2] una ∼ loro: *in interl.*
[3] *post* buona *del.* di me

né aiuto né consiglio, solo li compatisco col'affetto.
Il Padre Frate Angelo mi ha detto che risponderà lui a V.S. d'intorno ai suoi particolari (...).
Di Milano li 8 di agosto 1612
Di V.S. m. Ill.re
Aff. et oblig.mo ser.re
Mutio Oddi

The following letter from Oddi to Pier Matteo Giordani mentions also Guidobaldo's commentary on the fifth book of Euclid's *Elements*. Unfortunately it is not clear what the opinion shared by Baldi, P.M. Giordani and Oddi was:[1]

Molto Ill.r Signor e Padr. mio,
(...) Ho sentito con molto gusto che il S. Abbate Baldi e V.S. sieno concordi col mio parere d'intorno ai *Comentarii sopra il Quinto Libro <di Euclide>*, e così credo che faranno anco circa l'altre cose dalla *Coclea* in poi. Nell'opusculo dell'*Horologio coi raggi infranti* stimano sommamente l'inversione perchè quanto all'operatione del problema, [cosa] molto triviale, è [dozinalissimo] una semplice pratica senza niuno artifitio; ma essendo stata avertita da altri, non so che dire, ho a [causela] con l'occasione che faccio tagliare le figure dell'opusculo che feci [prigione]. Ho fatto tagliar anco quella perché se V.S. et il S. Abbate giudich[eranno pure] che si debba stampare, mi regerò col lor consiglio.
Di Francesco di Padiglia, Generale dell'artiglieria, ho auto carico d'andar a trovare il Ser.mo di Savoia (...). Di Milano li 12 di giugno 1613.
Di V.S. m. Ill.re
S.re Aff.mo et Oblig.mo
Mutio Oddi

At the beginning of 1614, almost four years after the first attempts[2] to edit the *Cochlea*, the efforts became more concrete: Orazio tried to supervise the works from Venice. The letter further contains interesting hints at the involvements of the "Padre Servita", possibly Paolo Sarpi, and another "Paduan mathematician":[3]

(...) e devo dirLe che vado Governator del'Armi di Candia per questa Serenissima Repubblica (...).
Ho scritto perché siano mandato qua di novo le figure et libro della *Coclea* volendo far prova se si potrà recuperar la fama a queste stampe et l'Ill.mo S. Lorenzo Giustiniani ne avrà diligentissima cura et dei

[1] Cf. BOP, ms 413, fol. 15r/v.
[2] Cf. in regard the letter of 16th June 1610, exposed above; BOP, ms 412, fol. 52r/v.
[3] Cf. BOP, ms 412 fol. 55r; Orazio dal Monte to Pier Matteo Giordani; February 8th 1614.

correttori si avranno D. Paolo quel tal [Padre Servita] virtuoso uomo et famoso per altri maneggi, et il mattemattico di Padova volendo star 3 giorni per foglio [oltra] un altro Ill.mo chiamato il S.r Antonio Calbo che offerisce sicurtà grandissime per la correttione.
V.S. mi disse già un suo pensiero per mettere nella fronte del libro ch'avea suggetto com'è giusto con l'istesso libro: se ha cosa a proposito me ne favorisca, se non Lei pensi et se saranno mandati qua le figure delle *Mecaniche* si ristamparanno donando 12 scudi al Padrone delle figure. Et a V.S. bascio le mani. Di Venetia 8 febbraio '14.
Di di V.S. M.to Ill.re
Obligatissimo Ser.re
<Oratio dal Monte>

The following letter from Uguccione dal Monte to Pier Matteo Giordani is significant since it documents the collaboration of Francesco Guerrini, disciple of Guidobaldo, who had apparently drawn the figures of the *Cochlea*.[1]

(...) In quanto ai libri della *Coclea*, il stampatore è in obligo con convenu[toni] con la beata memoria del S.r Oratio mio fratello di darne cinquanta e se voleva ritenersi le figure di darne 10 scudi al <Francesco> Guerino, veda quello che puol' [aborire] con esso.

I.8 Documents concerning various aspects of Guidobaldo's practical and scientific activity

I.8.1 Military engineering

Maybe the earliest extant testimony of Guidobaldo's occupation with military engineering is contained in the following letter from Guidobaldo to F. Pigafetta of December 31st 1580. It refers to a plan of the fortification of Corfù that Guidobaldo had drawn in the past:[2]

Molto mag.co Sig.or mio,
Ricevei il restante che mi mandò della traduttion delle *Mechaniche*, il quale Gli rimando, avendolo già veduto: e perché in una Sua dice, che io ho fatto non so che sopra la fortezza di Corfù, Gli dico che è vero, ma che è una bagattella, e non è cosa da esser veduta in modo nessuno, perché quel poco che io dissi, lo feci per obedir un amico, al qual non potei mancar, se ben lo feci malvolentieri; prima per non giudicar le cose degli altri, poi perché io non ho veduto se non un piccolo dissegno

[1] Cf. ms 412 fol. 84; Uguccione dal Monte to Pier Matteo Giordani.
[2] Cf. BAM, R121 sup, fols. 23r-24r.

> di detta fortezza, tanto più che io abbi una pochissima informazione del sito. V.S. potrà vedere se lo può avere dal capitano Riccio, che sta con il Sig.or Paulo Orsino.
> Ma perché La vederà una gofferia, non vorrei che La lo vedesse; che, come V.S. sa meglio di me, il voler dar questi giuditii bisogna andar in fatti, massime quando sono siti stravaganti. E se La lo vede, la veda, che io dissi quel manco che io poddi, essendoci dell'altre cose, che non mi piacciono, se ben'io (come dell'altre cose ancora) me ne intendo poco. E se il S.or Giulio Savorgnano lo vedrà, La prego a far mia scusa, et a basciargli le mani in mio nome. (...)

The next letter of January 21st 1581 testifies that Guidobaldo seems to have made also an "expertise" ("*discorso*") on the the fortification of Corfù.[1]

> Molto mag.co S.r mio,
> non voglio ch'Ella creda ch'in me non sia cosa che La possa disporre però Li mando una copia del mio discorso intorno alla Fortezza di Corfù la quale è precisa come quella ch'io mandai al Capitano Riccio a inquisitione del S.r Paolo; sopra il quale discorso non starò a farne più scusa. Li dirò solamente che se Li parerà che sia goffo non lo lasci vedere s'altramente **. La ne faccia quello che Li torna comodo e servitio. (...)

The following letter of the architect and military engineer Girolamo Arduini to the Duke of Urbino[2] speaks of certain measures and projects concerning the fortification of a not nearer specified place. In its course, Arduini refers to the "opinion and map of Sir Guidobaldo" – a clear hint that the latter was active in the capacity of military engineer also in the Duchy of Urbino.[3]

> Ill.mo et Ecc.mo Sig.r mio sing.mo,
> si fanno i fossi fuori delle fortezze delli quali una sponda fu al muraglia, et l'altra la contrascarpa di terreno, acciò che gl'inimici non possano correre alla sfilata nel assalire le mura della fortezza et ofenderle, come ancora per coprire i deffensori che in essi fossero ** et ** fogli (come l'altra parte delle fortezze) i siti proprii ci mostrano la forma che devano avere; li quali o ci è premesso di affondarli sotto o no; quando si possano cavare si cavano secondo il [rodo] e firmamente da edificarvi; quando non si possano cavare o ben poccho, come ne' sassi

[1] Cf. BAM D34inf, fols. 103r-104v; Guidobaldo dal Monte to F. Pigafetta.

[2] As the letter is not dated, it is not clear if the recipient was Guidobaldo II della Rovere (died in 1574) or his son Francesco Maria II.

[3] Cf. BOP, ms 434 fols. 15r-18r; the letter has independently been discovered also by F. Menchetti, who transcribes passages of it in *Guidobaldo del Monte nel Granducato di Toscana e la scuola roveresca di architettura militare*, in *Guidobaldo del Monte (1545-1607). "Mathematics" e technics from Urbino to Europe*, cit.

vivi, acque, paludi o che molto vicina ella sia al piano della campagna, come è questo nostro luogo del quale ora ci occorre di ragionare, il quale al mio parere doveria essere solo sì profondo come si ritrova ora il piano del fosso vecchio acciò che l'acqua non abbia scaturendo a causarci male aere, et largo al parere e disegno del Sig.r Guid'Ubaldo, et averse oltre la capenza del fosso una giunta et altezza di sei in sette piedi che in tutto [scendesse] all'altezza di diece in undici piedi et che ad esso ciglio se gli potesse ascendere commodamente, di modo che il proprio piano del fosso ci serviria per strada coperta. (...)

I.8.2 Guidobaldo between theory and practical "experiences"

The following letter from Guidobaldo to Giacomo Contarini is most interesting from Guidobaldo's conception about the interplay between mathematical theory and practical "experiences":[1]

Ill.mo Sig.r mio oss.mo,
La Sua m'ha dato grandissimo contento in veder che Ella tiene memoria di me Suo servitore. Mi dispiace però che La sia stata travagliata dal male così lungamente. Mi rincresce ancora ch'io non fui presente quando V.S. Ill.ma era dal Signor Giulio Savorgnano, sì per esser in quella dolcissima conversatione, come anche perché so che averia imparato molte cose, in particolare sopra le machine, sopra le quali V.S. Ill.ma m'invita a voler dir il mio parere circa la esperienza e la dimostratione.
Sopra le quali discorrendo brevemente La deve sapere che prima che io abbia scritto cosa alcuna sopra le *Mechaniche*, mai (per non far errore) ho voluto determinar cosa alcuna per minima che ella sia, se prima io non vedeva con effetto che la esperienza si confrontasse apunto con la demostratione, e di ogni minima cosa ne ho fatto la sua esperienza. Dove ho anco fatto una libra la quale mi mostra verissimamente che avendo il centro nel mezzo di essa, mossa la libra dove si vuole, sta ferma dove si lascia, come dice la quarta proposizione *De Libra* nel mio libro delle *Mechaniche*, che è cosa che dà fastidio a molti che non l'hanno saputa far materialmente.
Insomma, questa è cosa sicurissima che la pratica con la theorica vanno sempre insieme, né si discostano punto l'una dall'altra. Et di più Le dico che la dimostratione mi ha insegnato assai come si hanno da far l'esperienze, sopra le quali per chiarirsi bene bisogna considerar

[1] Cf. BNMV ms. It. IV, 63 = Ven. 259; October 9th 1580; published in A. Favaro, *Due lettere inedite di Guidobaldo del Monte a Giacomo Contarini*, in "Atti del Reale Istituto Veneto di scienze, lettere ed arti", LIX 2 (1899-1900), pp. 307-310.

molte cose: primo che gli instrumenti siano piccoli più presto che grandi; come per essempio le taglie con le sue girelle, che se fusse possibile di farle di ottone con li sui assi di ferro sottili sottili; et che le girelle siano benissimo tornite, le quali non balassero attorn'agli assi, ma però che girassero con un soffio se fosse possibile, questo sarebbe benissimo. Perché le taglie grandi, che sono atte a levar gran pesi, non sono così buone a chiarirsi delle minutezze, sì come si mostra con essempio chiaro nelle bilancie che, per chiarirsi d'ogni minutia, bisogna tuor quelle piccoline da pesar li scudi, et non quelle di legno grande, che si pesano cose grosse come carne et simili, se ben tutte sono giuste.

Ora fatto questo, circa il mio libro <*Mechanicorum Liber*> e d'avvertire una cosa molto principale la quale ha fatto ingannare molti circa le esperienze: che è ch'io fo gran differenza dalla forza che sostiene un peso, e da la forza che lo move. Come per essempio nella terza proposizione *De Trochlea*, dove dice: se la fune sarà menata per due girelle etc., che allora la potenza che sostiene sarà la metà manco del peso. Questo l'esperienza Glelo mostra giustissimamente in questo modo: La metta in alto le taglie come sta la figura di detta terza proposizione, e La metta in A un peso di sei libre, et in N vi attacchi un peso di 3 libre il quale fara l'offitio della potenza; senza dubbio la trovarà che staranno fermi, et questo è quanto alla schietta proportione. Ma perché in atto pratico in questo caso la taglia di sotto, dove è attaccato il peso, ancor ella ha gravità, però bisogna pesar la taglia et il peso insieme, e la metà del tutto metter in N. Come se, per essempio, il peso con la taglia pesaranno 7 libre, bisogna in N attaccarvi 3 libre et $1/2$, sì come io avertisco a carte 101 nella seconda facia, dove in qualche caso bisognarebbe considerar ancora la gravità delle funi, la quale in questo caso si può tralasciare, massime per le taglie piccoline, per adoperarsi spaghi et cordicelle sotili; et in questo modo le 3 libre et $1/2$ in N et le 7 in A staranno ferme, perche le 3 libre et $1/2$ in N non hanno forza di mover le sette in A, né queste di mover le 3 $1/2$ in N, come dimostra la dicianovesima proposizione del medesimo trattato *De Trochlea*. Per aver adunque la potenza cognita, quando io parlo e che dico "*potentia sustinens*", si ha da intender che l'abbi tanta forza che la facci star il peso immobile, cioè sospeso e non più, e non come hanno creduto alcuni, che questa forza abbi da mover il peso, perché la sua forza et il suo valore è solo bastante a sostenere e non a mover il peso, e cosí si ha da intendere sempre questo termine *potentia sustinens*, sí come s'intende chiaramente dal corollario della prima propositione *De Trochlea*.

Et se La considerarà nei problemi che sono nel libro, nei quali io propongo de mover i pesi, allora io fo la potenza sempre maggiore di

quella che sostiene, et in questo modo gli riusciranno benissimo tutte le esperienze. E così bisognava fare per provar la giustezza e la proportion che ha la forza con i pesi: perché, stando nel medesimo esempio, e le 3 libre e 1/2 in N sostentano il peso in A, la ragion vuole se in N si mettera un peso maggiore di 3 libre e 1/2, che questo senza dubbio mova il peso di 7 in A, ma questo che move pol esser 4 libre, 5, 6, 10, 20, 100 libre e così in infinito, e però non se ne puo dar regola certa.

E' ben vero [che] in questo la materia fa qualche ressistenza, che se sopra le 3 libre e 1/2 poste in N se gli aggiongesse un peso di minima gravità come un gran di miglio, allora se ben saranno piu di 3 1/2, non per questo moveranno le 7 in A; e questo ne è causa la materia, la qual vuol la parte sua ancor lei, e quanto sono piu grandi in materia, tanto piu ressiste. Si come si prova tutto il giorno nelle libre che, per picole e giuste che le siano e che abbino pesi da tutte due le bande eguali e giusti, non di meno a un di loro se gli potra metter sopra et aggiunger un peso di tanto poco momento come un minimo pezzolino di carta, che la bilancia stara senza andar giu da detta parte, ne per questo la bilancia sara falsa.

Dove è da considerare che la ressistenza che fa la materia lo fa quando si hanno da mover i pesi e non quando se hanno da sostenere solamente, perché allora l'instrumento non si move né gira, e con queste considerazioni La trovarà sempre che l'esperienza e la demostratione andaranno sempre insieme.

Quanto poi alle due domande che V.S. Ill.ma mi ha scritto, la prima ha due capi: il primo che tutti gli strumenti di ruote che passano tre rochelli e due ruote, sono inutili per la sua tardita, il secondo capo è che quelli che ne hanno manco sono deboli e di poca forza. Quanto al primo capo dico che è vero che sono tardi, nondimeno hanno questo vantaggio che con poca forza moveno grandissimi pesi, et per questo rispetto non sono da sprezzare, si come raconta Pappo che Archimede ne aveva fatto uno di cinque ruote con i suoi rochelli, acciò che pochissima forza movesse grandissimo peso. Circa il secondo capo dico che quelli hanno manco forza di quei primi, ma hanno poi questo di buono che movono più presto; e però a mio giuditio tutte queste due sorte di machine sono buone, perché quando si hanno pesi smisurati e che bisogni moverli con poca forza, il primo modo sarà buono, quando poi li pesi non saranno tanto grandi si potrà far con manco ruote mover più presto et per non perder tempo. Ma però qui e da considerare che non si può dar regola ferma circa tali instrumenti, perché si può far che una ruota sola faccia il medesimo e preciso effetto come se fussero due, 3, 4 con i suoi rochelli e piu, come si può cavar facilmente dalle cose che ho detto nell'*Asse in Peritrochio*.

Circa la seconda dimanda dove dice che le taglie da sei rotelle sono di buona forza e godibili, è vero. La dice poi che non Gli riesce la proporzione da uno a sei, ma da uno a 4, questo me ne meraviglio perché io ne ho fatta la esperienza più volte, e se La tornarà a far l'esperienza con quelle conditioni che ho detto di sopra, e L'accomoderà le taglie in questo modo che è qui dissegnato, s'el peso in A con la taglia di sotto pesarà 12 libre, attaccando in B due libre, dico che queste due sustentaranno le 12 infallibilmente, e sarà la proportion de uno a 6, e questo dico che sostentarà ma non moverà.
La mi farà favore, se non restarà satisfatta di quanto Le ho detto di sopra, a farmene moto perché non mancarà di dirLe quel più che stimato atto a poterLa contentare, se ben mi par d'aver detto troppo, che averò fastidito V.S. Ill.ma, ch'el tutto ho fatto per ubbidirLa. Che se io non averò saputo farmi intender, mi chiarirò meglio quanto comporta il mio poco sapere, pregandoLa a darmi aviso come Le reusciranno le esperienze fatte nel modo che ho detto di sopra, e di scriverlo ancora al Signor Giulio Savorgnano al quale V.S. Ill.ma mi favorisca, se La me gli raccomanderà et raccordarà per suo affezionatissimo servitore e gli bascierà le mani in mio nome.
Circa Pappo io credo che quelli che si trovano siano tutti scorrettissimi, intendo però che quello che è nella Libraria Vaticana del Papa è assai corretto, con il quale V.S. Ill.ma lo potrà far incontrare. Non voglio esser più lungo che pur troppo sono stato, ma prego che La mi tenghi per servitore Suo affetionatissimo et mi comandi basciandoLi le mani, che Dio La contenti. Di Pesaro alli 9 d'ottobre del 1580.
Di V.S. Ill.ma
Aff.mo ser.re,
Guido Baldo
de Marchesi del Monte.

The following letter from Guidobaldo to Filippo Pigafetta testifies the dispatch of an isostatic balance from the former to the latter. The "mastro" who had fabricated the two compasses, that the Marchigian mathematician sent to Pigafetta additionally, seems to be Simone Barocci:[1]

Mand'a V.S. li compassi et la bilancia. Li compassi Glene mando due para, perché uno serve per far li circoli, l'altro poi per misurar, et hanno le punte di acciaro. Credo che piaceranno a V.S. perché invero il mastro è eccellente.
La bilancia sì che credo che Dio sa quel che La riuscirà, bisogna che V.S. l'attachi, perché non si può cosí tener saldo con la mano che basti poi quando La moverà la bilancia, bisogna avertir che la non

[1] Cf. BAM, D34 inf., fol. 139r; May 2nd 1581.

pigli l'andar o in su o in giù, perché ogni minima cosa la fa muovere; et Dio voglia che nel portarla la non si muova. Io l'ho provata molte volte et sempre è stata dove la si è lasciata.
Averò caro che V.S. me ne avisi, e s'ella è mal fatta, (per non defraudar alcun mastro) La non si meravigli perché l'ho fatta io medesimo, però se La si guasta io ne rifarò un'altra. E mi basta di mandarglela così goffa perché mi basta che la serva a V.S. per mostra, acciò La ne facci far una da quel mastro buono et La potrà far far come quelle che si pesano li scudi e Gli bascio le mani. Di Pesaro alli 2 di maggio 1581.
Di V.S.
S.re Guidobaldo
de' Marchesi del Monte

I.8.3 Documents on Guidobaldo's interaction with his environment

The composition of Guidobaldo's circle

The following letter is fundamental for the question of Guidobaldo's philosophical-mathematical environment.[1]

Molto mag.co Sig.r mio hon.do,
Le bascio le mani della fatica usata nelle lettere che Gli ha mandato il Signor Giulio Veterani. Dopo che son qua su non ho sentito gran caldo, ma spesso assai fresco.
Io vorrei invitar tutti i filosofi che mi favoriste di venir a favorirmi qua su. Ma M.s Tiberio non farebbe poco se invitandolo adesso ci venisse quest'altra estate, che mi dubbito che siano passati li gran caldi senza li quali egli non pò andar atorno. Il Padre Pucci non so se ci venisse perché non ci sono li Frati di S. Domenico. L'Arditio non so se potesse lassar la lite, acciò non si desertasse. M.s Virg.o Almerici non pò lassar l'agricoltura.
Circa la persona Vostra, se il levar tardi o qualche negotio del Marino non Vi tien occupato, io ci ho qualche speranza, massime se il S.r // Camillo Mazza et Voi Vi farete animo l'un l'altro. Ma mi avete promesso e però spero che attenderete. Io bascio le mani a tutti tutti.
Di Monte Baroccio alli 10 di agosto del 1588.

Guidobaldo's letter to Federico Bonaventura of 1588

Apparently, Guidobaldo's interest in "pure" philosophy was connected also with discussions about natural philosophy he had with his interlocutors: a testimony

[1] Cf. BOP, ms. 426, fol. 159 r/v; August 10th 1588; Guidobaldo to Pier Matteo Giordani.

of this fact is the following letter written by Guidobaldo to Federico Bonaventura in 1588. Apparently, the Urbinate philosopher had asked Guidobaldo his opinion about a (philosophical) writing of his. Therein, he had apparently attacked the theory of the tides of the Tuscan philosopher Andrea Cesalpino, exposed in the *Peripateticarum Quaestionum Libri Quinque* (1571).[1]
Guidobaldo encouraged Bonaventura to publish his work, because he himself, interestingly, wanted to cite and refer to it in an own work of his, called *De Motu Terrae*:[2]

> Molto Magn.co Sig.re mio hon.do,
> V.S. mi fa vergognare con tante cose, per non dir cerimonie, che usa nella Sua lettera, ma conosco che lo fa per spronarmi a far qualche cosa. Con tutto ciò io Glene resto obbligatissimo insieme con la scrittura che mi ha mandata, che mi duole di averli fatto durar questa fatica doppia, cioè di averla rescritta e di averla fatta in buona forma. Io non l'ho ancor potuta leggere, che appena gl'ho data una scorsa così in furia, che non Gli posso dir cos'alcuna di fermo se bene mi è piaciuta infinitamente.
> Ma non so però se V.S. tocca niente contra il quinto capitolo del medesimo terzo libro, dove mi par che quest'uomo non consideri troppo bene quello che dice, perchè vuole che la Terra abbi il moto della trepidatione, che avendo lei questo moto, dice il Cisalpino, che non accade di darlo al cielo, come che 'l cielo abbi questo moto ogni sei ore, come vuol che abbi la Terra poi che quest'è causa del flusso del mare. Ma vuole però che questo moto della Terra venghi dal cielo, ma se dal cielo, la Terra si doverebbe mover in giro come il cielo. Ma si vede che attribuisce alla Terra il moto della trepidatione per salvar il flusso del mare, ma e cosa poco da filosofo per salvar il moto del mare indurre nella Terra un altro moto piu stravagante, che per salvar questo della Terra bisognava trovarne un altro, e poi un altro, e così in infinito. (...)
> Pesavo poi a metter in esecuzione il pensier che tiene di mandar fuori il primo e il secondo libro, di grazia non manchi di farlo, che sono certo che averà onore et satisfattione grandissime, e di più Gli sarà poi un stimolo a finir gl'altri libri. La lo facci adunque et quanto più presto. Dove La dice di nominare me, non lo facci per niente, che queste poche cose che io Gli ho detto di sopra, Dio sa se staranno così.
> Averei ben caro che V.S. mandasse fuori questi due suoi libri, che so che mi serviranno a me per citarlo et lo farò volentieri, massime che

[1] A. Cesalpino, *Peripateticarum Quaestionum Libri quinque*, Venezia, Iuntae, 1571.
[2] BCF, Autografi Piancastelli, 755; the letter is published in D. Bertoloni Meli, *Guidobaldo dal Monte and the Archimedean Revival*, cit.

ho un capriccio che la Terra si muova, et questo in via di Aristotele. Ma sono cose che (come Lei sa meglio di me) bisogna prima pensarci bene, e non le lascierei vedere se prima io non avessi il consenso di primi filosofi, acciò mi faccino accorger del mio errore, se viè, perché io da me stesso confesso che non me ne so accorgere. E quanto più ci penso, tanto più mi ci confermo. Tra i primi voglio il Suo giudizio stimato da me più forsi (per dir così) di quello che Lei si crede. (...)
Il Conte Torquato graziosamente mi rese il libro che V.S. mi mand o. Che Gl ne bascio le mani, et il medesimo fa mia moglie alla Sua Signora consorte. E mi comandi. Di Pesaro alli 8 di dicembre del 1588.
Di V.S. ser.re
Guidobaldo dei Marchesi dal Monte

Folio 451 of BUU, Fondo del Comune, 120, Cart. 3

Another testimony of Guidobaldo's interaction with his scientific environment is the following letter to an anonymous interlocutor about a problem concerning the conical sections.[1] The reasoning refers to figure I.6.

La pratica della dimostratione del cono scaleno
Si facci abc il triangolo del cono eretto alla base e si divida ab in due parti[2] eguali in e. E si facci ef particolare all'ab secondo l'altezza del stile e si tiri cfh. Poi fatto centro e con l'intervallo eb, si descriva il circolo abk che sarà il circolo della base. E sia d il punto della data ora. Poi si tirino hkd et ed. Poi si facci el perpendicolare a ed et eguale a ef e si tiri ld. Poi si facci il triangolo mno e sia mn eguale a fh, non a hd, et mo a ld. E si slunghi nm in p, e sia nmp eguale a hfc. Poi si facci nq eguale a hk e si tiri qp, la qual seghi mo in r. Poi si facci ls eguale a mr, e si tiri st perpendicolare a ed, la qual sarà particolare, dove casca nel piano della base dal punto dove il raggio sega il cono. Sì come appare, se stando ferme ab, hd et ed si elevaranno li triangoli chb, eld eretti alla base. Et no, np fussero ** perché allora li punti fl sariano un punto solo, et il punto q saria in k et ** un punto solo. Et st saria la perpendicolare che casca nel piano della base **.

[Quanto] alla Sua pratica che mi mandò, dubbito che non ci siano alcune **. V.S. potrà paragonar con questa, e vedria se ci è mancame[nto.]

Quanto poi scrive del cilindro, credo che stia bene, ma non lo ** avend'io specolato niente sopra questo.

[1] Cf. BUU, Fondo del Comune, 120, Cart. 3, fol. 451r.
[2] parti *correxi ex* part

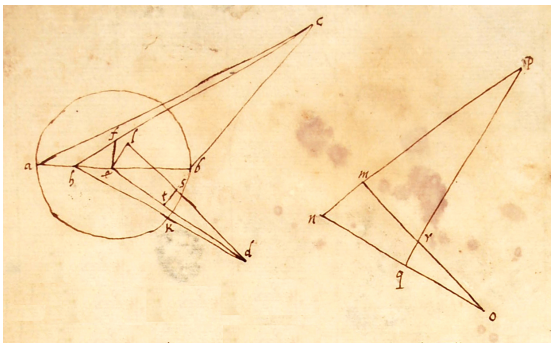

Figure I.6: The respective figure.

Page 6 of the *Meditatiunculae*

Another important testimony of the stimuli Guidobaldo received from his scientific environment is constituted by page 6 of the *Meditatiunculae*: it is entitled "The problem proposed by Count Giulio da Thiene" (the reasoning refers to figure I.7):[1]

> Problema proposto dal Conte Giulio da Thiene
>
> Sit triangulum abc, et ac latus maius latere bc, sit autem ed ipsi ac aequidistans, et connectatur ad, et fiat ut de ad db, sic ad ad aliam quae sit af,[2] et a signo f ducatur fg ipsi ed aequidistans. Dico lineam fg aequalem esse db.
> Quoniam enim fg est aequidistans ipsi ed, triangulum aed aequiangulum et simile erit triangulo agf,[3] quare eandem habet proportionem da ad af, quam ed ad gf. Proportio vero, quam habet ad ad af, eandem est, quam habet ed ad db sicut igitur[4] ed ad gf, sic ed ad db,[5] ergo gf ipsi db est aequalis,[6] quod erat demonstrandum.
> Sit ac aequalis cb, erit et ed aequalis db et fiat ut ed ad db, sic ad ad aliam, quae erit ad,[7], punctum d erit punctum quaesitum.
> Sit ed minor db, et fiat, ut ed ad db, sic ad ad aliam, quae sit af. Et a signo f ducatur fg ipsi ed aequidistans, erit fg aequalis db.
>
> Questo[8] problema serve assai alla prospettiva che essendo l'occhio in

[1] For further information about Giulio da Thiene, cf. Appendix II, II.1.
[2] *in margine* 12 sexti *Elementorum*
[3] *in margine* per 4 sexti
[4] sicut igitur *ex* igitur sicut
[5] *in margine* per 11 quinti
[6] *in margine* per 9 quinti
[7] *in margine* per quartam sexti ob similitudinem triangulorum
[8] Questo ∼ *de :* *diverso atramento*

a e vedendosi la linea db, trovar la linea fg, laqual paia et sia equale alla db, e la settione sia sempre equidistante alla de.

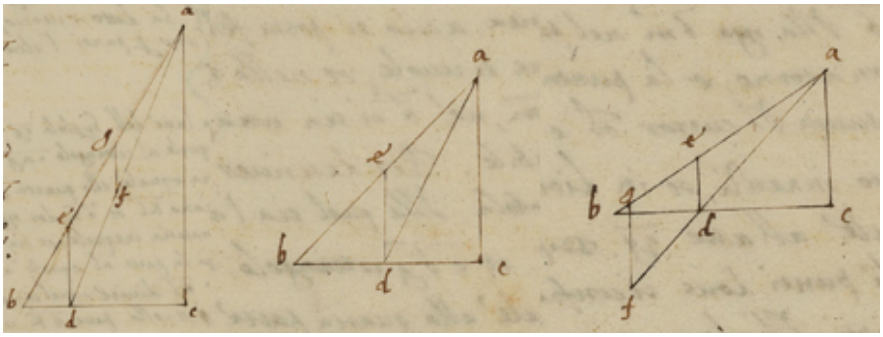

Figure I.7: The illustration of Guidobaldo's reasoning on Count Thiene's problem.

I.8.4 The "Letter to the Goth", debates at Pesaro and the dispatch of an isostatic balance to Spain

The "Letter to the Goth" is one of Guidobaldo's most informative extant letters, from a theoretic-conceptual point of view.[1] It deals with his theory of the isostatic balance that predicted the existence of indifferent equilibrium: the letter is highly interesting for a reconstruction of Guidobaldo's Theory of Equilibrium.[2]

> Molto Rev.do Padre hon.do,
> Mi è stata sommamente cara la Sua per aver avuto nuova di Lei, particolarmente da Lei, se ben dal Padre Bellarminio quando passò di qua il Papa, et anche per esser stato di poi a Loreto da quei padri io avevo inteso che stava bene. E non si maravigli se non Le ho risposto prima, perché non ho ricevuta la lettera con il libro mandatomi dal dottor Adriano <van Roomen> se non l'altro ieri. Al qual come V.Rev.za risponderà, lo ringratiarà in mio nome senza fine. Mi rincresce che sia in lingua fiaminga. Pur qua ci sono dei fiaminghi dalli quali vedrò se ne posso intender qualche cosa.
> Ho poi veduto quanto scrive quel gentiluomo Goto contra Lei e contra me, e mi par che quest'uomo sia facile al contradire purché possa, forse non senza qualche sua albagia naturale. Ma non posso far di non dire che facci gran torto al maestro et che sia indegno Suo discepolo perché mostra di non intendere i termini.

[1] Cf. APUG, ms 530, fols. 188r-189v. The letter has been published by E. Gamba, V. Montebelli, *Le scienze a Urbino*, cit.; and in a commented version in Chr. Clavius, *Corrispondenza*, cit.

[2] Cf. Part B, chapters I and II.

Ma io sto con l'animo riposato perché averò buonissimo difensore, che so che V.R.za gli mostrarà la sua ignoranza la quale lo fa anche un poco arrogante. E perché mi ricerca, dirò qualche cosa, se ben non lo doverei fare, perché V.Rev.za sa et intende meglio di me. Tuttavia mi par che questo Goto abbi bisogno che io gli dichiari il centro della gravità, la prima propositio di Pappo dell'ottavo libro <delle Collectiones Mathematicae>, et le altre cose che cita in suo favore, le quali mostra d'intendere molto poco.

Ma per venire a qualche particolare, dice il Goto che io non intendo che cosa sia aequeponderare, et io certo confesso di non intendere che aequeponderare sit aequaliter distare ab horizonte tantum, et non aequeponderare sit quando libra non est horizonti aequidistans: che mai più ho inteso simil definitione e non trovo chi la dica, che questo saria un distruggere la definitione del centro della gravità .

Ma forse vuol dire il Goto che io ho mal usato quel termine: ma questo non saria niente che al fine si hanno da intendere le cose di quel modo che gli autori le hanno usate. Ancorché mi pare che se la libra della qual si parla (cioè com'io la piglio nella quarta propositione delle Mechaniche), manet quand'ella non è equidistante all'orizonte, ne seguita che li pesi et ogni cosa aequaliter ponderent, donde si può dire e si deve dire che in quel sito aequeponderant, quia alterum aequeponderant alteri, altramente aequaliter non ponderent, et per consequenza non manerent.

Ma questo saria un trattar delle parole, che venendo alle cose doveva il Goto, se la mia seconda supposizione delle Mechaniche è falsa, [provar] la sua falsita, overo nella dimostratione trovar le parole dove sta la falsità; ancorché io non provo la quarta propositione delle mie Mechaniche per la seconda suppositione, come lui dice, ma per la definitione del centro della gravità, onde si vede quanto poco intenda il Goto; è ben vero che poi la confermo per questa suppositione per l'impossibile. Ma perché la verità è una, è necessario al Goto di mostrar dove è la falsità della opinione contraria, sì come io faccio con quelli che tengano la opinione contraria alla mia. Perché non basta il dire che quando la libra non è // equidistante all'orizonte, che non equepondera per l'autorità di Archimede, Eutocio e Pappo, perché questo al fine non sarebbe altro che mostrare che io non ho usato bene questo termine equeponderare. Con tutto ciò, se li pesi in quel sito non aequeponderant , non è vera la dimostratione ch'io faccio, e però trovi il Goto la falsità nella dimostratione come si e detto. Ma perché mostra di non intendere il modo dell'argomentare del centro della gravità all'equeponderare, potria leggere quel che io dico nelle mie Paraphrase sopra il libro d'Archimede De aequeponderantibus nella quarta propositione, che forse si chiarirà se però vorrà intendere.

Ma poiché fonda le mathematiche sopra l'autorità, dico che quando Archimede parla nel libro De aequeponderantibus nei principii, come anche in tutti due quei libri, non nomina mai l'equidistantia all'orizonte , che di questo ne verbum quidem, che trattando sempre del centro della gravità quando li pesi sono sostenuti in quello, vuole che in ogni sito maneant ac per consequens aequeponderent.
Che questo ho mostrato nelle mie Paraphrase sopra quel libro, che chi intende bene Archimede lo deve intender così, altamente non sariano vere niuna delle consequenze che fa. E così le propositioni e le dimostrationi sono più universali e più belle che se le dimostrassero solo quando la libra è all'orizonte equidistante; che se le dimostrazioni d'Archimede fussero vere solamente quando la libra è equidistante all'orizonte, l'averebbe detto perché questa era condition necessaria da dirsi. Non l'avendo adunque detto, chiara cosa è che intende manere et aequeponderare quando la libra è in ogni sito, se bene Archimede, per parlar ancora più universalmente, non nomina la libra, ma distantia ex quibus.
Eutocio poi nell'esporre i principii d'Archimede De aequeponderantibus, se ben dice che Archimede intende quando una figura, o libra, è sospesa nel centro della gravità, che la figura e la libra sta equidistante all'orizonte, dice il vero. Ma non seguita però che non sia vero questo quando non sono ancora equidistante all'orizonte; et Eutocio di questo non ne dice pur una parola perché chi intende che cosa sia centro di gravità et equeponderare, presto intende benissimo quanto si è detto.
Pappo poi nella prima <propositione> del ottavo // suo libro <delle Collectiones Mathematicae> niuna parola tratta dell'equidistanza all'orizonte; che volendo dichiarare la natura del centro della gravità, e come si trovi in tutti li corpi, lo trova per li segamenti che fa delli corpi con li piani perpendicolari all'orizonte. Onde in quella propositione vuol trovar le linee perpendicolari all'orizonte e non quelle che sono all'orizonte equidistanti, che di queste ancor lui ne verbum quidem. Anzi, questa dimostratione di Pappo è contraria alla definitione che dà il Goto dell'equeponderare, dicendo che l'aequeponderare est horizonti aequidistare, e Pappo vuole che li corpi possino equeponderare per tutt'i versi, massime che li corpi si posson dare che non ci possi esser mai l'equidistanza all'orizonte.
Io poi averei molto caro di veder le ragioni naturali del Goto con le quali prova la mia supposizione e dimostratione esser false, che mi sarà caro di veder come le cose mathematiche si provino con li mezzi naturali . E perché il Goto desidera di aver e saper quelli che hanno l'opinion contraria alla mia, credo che li possa dir che tutti tengano da me (ch'io sappia), ma gli doverà bastare il vedere che V.Rev.za sia

di questa opinione contraria alla sua, ma mi dubbito che non la vorrà publicar in Spagna per non si far vergogna.
Mi par sopra questo aver detto troppo, rimettendomi a quello che Le piacerà di scriver Lei. In quello poi che tocca a V. Rev.za mi par che similmente il Goto abbi il torto et che tocchi a lui a dichiarar come intende questa sua proportion dupla in questi numeri 1, 10, 100 e solvere poi quanto ha detto V. Rev.za. Che se vuole intender dupla per duplicata, sta bene sì come V. Rev.za verso il fine sopra la decima definitione del quinto libri di Euclide in quelle parole "Propter duas propositiones quae inter" etc. Altamente non saprei mai quello che si volesse dire quest'uomo; dal quale, se ne averà altra cosa, mi favorisca di farmene partecipe.
Quanto alli miei problemi, essendo tanto tempo che non gli ho veduti, che ho atteso alla Prospettiva, che essendomene fatta molta instanza, l'ho finita con animo di stamparla presto.
Mi piace poi che facci un altro calendario et anche che scriva degl'orloggi, che per esser le cose Sue in tutta perfettione mi sarà carissimo di vederli. E Le bacio le mani. Che Dio La contenti. Di Pesaro alli 28 di luglio del 1598.
Di V. Rev.za
per servirLa, Guidobaldo dal
Monte

At the Biblioteca Universitaria of Urbino,[1] a partial copy of this letter is conserved, made by Muzio Oddi. The copied passage begins with the wording "anzi questa dimostratione di Pappo e contraria alla definitione che dà il Goto del *aequeponderare*" and ends with "altramente non saprei mai quello che si voleva dire quest'uomo, dal quale se ne averà altra cosa, mi favorisca di farmene partecipe. Quanto alli problemi etc".
Oddi seems to have used this partial copy of the "Letter to the Goth" to write the following letter,[2] that he sent to an anonymous interlocutor, in order to inform him about Guidobaldo's controversy with Botwid von Närke.

Ho poi fatto vedere al S.r G.<uido> U.<baldo> quello che V.S. mi scrive per conto del rispondere al Goto et mi ha detto che io La ringratio della buona voluntà Sua et insieme La prega a non pigliar fatica di[3] mandare la sua scrittura in Spagna. Et essendo che il Padre Clavio si [era] offerto di voler fare lui questo offitio et dubita che non l'avesse a male, né essendo questa[4] questa scrittura pubblica ma scritto a lui

[1] Cf. BUU, Fondo del Comune, Busta 120, Cart. 3, fol. 410r/v.
[2] Cf. BUU, Fondo del Comune, Busta 120, Cartella 3, fols. 418r-419v.
[3] pigliar ∼ di *ex del. aliquot verbis*
[4] né ∼ questa *ex* massime che non è

per modo di consigliarsi[1].
Et di gratia il S.r G.U. ha inviato a esso Padre una sua scrittura fatta da lui più per compiacerlo che perché giudicasse neccessario il rispondera a persona tanto poco pratica delle Matematiche quanto è il Goto. Io l'ho veduta et mi è parso bella assai et ne scrivere qualche cosa di essa a V.S. acciò ancor Lei ne participasse, ma la memoria mi serve poco da diverso; pur per sodisfare al desiderio Suo, anderò mettendo insieme quelle poche cose che mi riccorderò di essa et di quei discorsi che questo Sig.r ha fatto a bocca con esso ma per facilitarmi l'intelligentia, ma con questo che V.S. mi escusi se seranno [posti senz'ardere] perché prima io non so et poi il sentirmi male, ch'è caggione che non possa supplire con la fatica[2] al mancamento dell'ingegno mio.
Et prima il S.r G.U.[3] confessa di non intendere che *aequeponderare sit aequaliter distare ab horizonte tantum*[4] et *non aequeponderare sit quando libra non est horizonti aequidistans* perché non si trova in autore alcuno questa diffinitione o per dirli nome più proprio // distruttione della diffinitione del centro della gravità che da Pappo nel proemio dell'ottavo libro fu diffenito così: "centrum gravitatis uniuscuiusque corporis est punctum" etc.
* [si vede] appertamente, quanto il Goto ** da Archimede citato da lui ** il modo di argomentare dal centro della gravità all'aequeponderare, il che aversi benissimo il Monte nella sua *Parafrase* alla 4 propositione, che non sono esse diverse come si crede colui, perché che i pesi posti nella libra, se ne compone un solo, dal quale va solo ch'il centro della gravità[5] pesi negl'estremi della libra, di questi se ne compone un peso solo, del[6] quale un solo è il centro della gravità. Come mostra Archimede nella 4a de <*Aequeponderantibus* ** or' se questa libra serà sospesa a questo centro et sia posta in sito in parallelo all'orizonte, dica di gratia il Goto, se i pesi aequiponderanno o no, se aequiponderano, dunque[7] i pesi sospesi nel centro della gravità aequiponderano senza altro [si sospeso all'[8]orizonte; et è falso quello che il Goto dice che ne seguiterebbe un absurdo: che libra super eodem gravitatis centro simul aequeponderaret et non aequiponderaret[9], se non aequiponderare[nt], ergo si per tale centrum ducati planum figu-

[1]ma ∼ consigliarsi *sublin.*
[2]con ∼ fatica *ex* col studio.
[3]il S.r G.U. *ex* Il Monte
[4]tantum *super lin.*
[5]che i pesi ∼ della gravità *ex* se posti doi
[6]*ante* del *del.* Et un
[7]*ante* dunque *del.* i pesi
[8]si sospeso all'*super lin.*
[9]et è falso ∼ et non aequiponderaret *in marg.*

ra quomodocumque secans semper in partes aequeponderantes non secabit che è contro alle cose dimostrata da Pappo nel primo dell'ottavo libro[1], di esso centro tratta del Comandino di dove trasse quella discrition d'esso centro nel *De Centro Gravitatis Solidorum*[2].
Di più dice che[3] questa libra si moverà o non posto in questo[4] sito: se si moverà serà falso quello che Pappo dice che *grave appensum // in centro gravitatis dum fertur non*[5] *quiescere nec*[6] *servat eam positionem quem habet in principio*[7]. Se non si moverà è adunque vera la 4a *De Libra* che il Goto dice d'aver publicamente negata.
Inoltre il Monte se ben mi riccordo[8] dice[9] che si possono dare i corpi che non abbiano, né possino aver anco[10] mai l'aequidistanza all'orizonte, et purre bisogna che quietino, col testimonio d'Archimede nella 6a *De Quadratura Paraboles* dicendo *unumquodque enim susponsorum et [quo] puncto constitutum est manet ** in linea perpendiculari sit punctum suspensionis et gravitatis centrum suspensi*; et tanto maggiormente quando sono sospesi nel cento istesso, che secondo il Goto ne seguiterebbe un moto continuno di questi corpi.
È ben vero che è contrasegno dell'equiponderare quando la libra[11] posta parallela all'orizonte sta fermo[12]; ma non seguita che non essendo parallela all'orizonte non possino aequeponderare che sarebbe un far particollare et un ridurre il millione al diece[13].
Quando è stato neccessario che la libra aequiponderando stà parallela all'orizonte, Archimede l'ha detto, così nella 6a <propositione> *De Quadratura Paraboles*. Et così dovremo credere che averebbe fatto nei [prop.ti] trattandovisi ** negl'*Aequeponderanti*[14] // se[15] fosse stata conditione neccessaria, dove non ha mai detto purre una parola di questa aequidistantia, né mai ha nominato orizonte.
* il Monte crede che costui non abbia ** altro in tutto quella ma ** che imputanto d'aver ** malamente questo termina aequeponderare,

[1] alle cose ~ dell'ottavo libro *ex* alla diffinitione
[2] di dove ~ *De Centro Gravitatis Solidorum in marg.* *del.* di Pappo
[3] dice che *in marg.*
[4] posto in questo *ex* da questo
[5] non *super lin.*
[6] nec *ex* et
[7] *in marg.* Contro alla diffinizione d'esso centro data da Pappo
[8] *post* riccordo *del.* la
[9] *super lin.* *del.* anco
[10] anco *super lin.*
[11] la libra *super lin.* *ex* i corpi
[12] *post* fermo *del.* così cognote anco dal senso
[13] et ~ diece *ex* quello che è universale
[14] *Aequeponderanti* *ex* de aeque
[15] *post* se *del.* l'avesse giudicato

> al che risponde d'averlo usato come l'usano gl'autori, et si contenta (se questo è errore) d'aver errato con Archimede et Papo. Perché se la libra, come il Monte l'intende nella 4a prop. *De Libra* nelle *Meccaniche*, *manet* quando non è anco parallela all'orizonte, ne seguita che li pesi et ogn'altra cosa *aequaliter ponderant*. Dove si può dire et si deve dire che in quel sito *aequiponderant, quia alter aequiponderat alteri, altramente non aequaliter ponderarent et per consequenza non manerent*.
> Il Goto poi dice d'aver negato la 2a Suppositio della Meccaniche ** che il Monte si crede d'aver mostrato la 4a De Libra. Prima, questa 4a prop non è stata dimostrata con la 2a Supp.o, ma mediante la diff.e del centro della gravità; ancorché poi la confermi con questa per l'impossibile; ma se questa supp.o è falsa perché non mostra egli[1] ** dove è la falsità ma

The conserved part of the letter finishes here. Therefore, both the recipients as well as the date are unclear.
The controversy with Botwid did not cease with this letter: several independent letter of the year 1599 inform us that Guidobaldo undertook efforts to send a balance to Spain. One of them is his letter to Pier Matteo Giordani of September 21st 1599.[2] The Marchigian mathematician intended to give it to Count of Carpegna who had to go on a diplomatic mission to Madrid on behalf of Duke Francesco Maria II della Rovere. Because of an anticipation of the embassy's depart, however, the punctual finalisation of the balance was threatened, as the letter documents.

The following letter from Oratio di Carpegna,[3] member of the embassy to Philip III on behalf of the Duke of Urbino, to the latter testifies that the embassy did not depart from Rome prior to the 12th of October. In the meantime of these weeks after their departure from Pesaro, Guidobaldo might have had time enough to dispatch it to Rome.

> Ser.mo Sig.re et P.rone mio sing.re,
> finalmente le galere arrivorno a Civitavecchia et dimani partimo per quella volta, sebene il S.re Card.le di Guevara si tratterà sino a passato domani, professando voler imbarcarsi subito all'arrivo suo se dal tempo le sarà permesso.
> Qui non ho lasciato nel licentiarmi da questi Ss.ri di replicarle quanto V.A.S.ma restò servita di commettermi; da quali pure mi è stato risposto in confirmatione di quanto scrissi nella prima mia a V.A. S.ma;

[1] egli *super lin.*
[2] Cf. BOP, ms. 426, fol. 176r.
[3] Cf. ASF, Ducato di Urbino, I, 127, fol. 700r.

che essendo quanto per ora devo dirLe, pregandoLe ogni contento et felicità a V.A., faccio umile riverenza di Roma alli 12 di ottobre 1599.
Di V.A.S.ma
Umiliss.o e divotiss.o ser.
Oratio di Carpegna

The following extract of notes of the Medici administration contributes to clear the following proceeding of the Urbinate embassy, which was in company with the Cardinal Guevara – interestingly, also Orazio dal Monte seems to have been in contact with the Urbinate embassy: this means another possibility of how Guidobaldo could have had his isostatic balance arrive in the hands of the Count of Carpegna:[1]

A dì 17 d'Ottobre 1599 L'Ill.mo e Rev.mo Card.le di Guevara spagnuolo da mattina a ore 18 e mezza stante il Gran Duca in Livorno arrivò in quel porto con 4 galere di Napoli e fu incontrato dal S.r Don Gio. <Medici> Ecc.mo sopra la galera turchessa di là del canale e condotto in fortezza, incontrato e ricevuto dal Gran Duca alla porta di detta fortezza et accompagnato alle stanza in su la sala grande al primo priano di fortezza e perché non aveva desinato, sentì messa nella solita cappella e se li dette desinare in detta sala grande e l'intertenne sempre il S. Don Gio. Ecc.mo che se bene già aveva desinato stette in una sedia a intertenerlo: lo servì di scalco il S. Pietro Sanminiati e si fece il piatto coperto con molte volarie e pasticcio caldo e freddo e quattro maniere di confettione con le frutta. Il piatto da basso per sei di sua tavola, conforme al di sopra tutto riccamente: tre piatti di seconda tavola con tre colatie e tordi per 20 sua gentiluomini nel audito della cappella serviti da m.s Antinoro e biscottini con le frutta: un piatto nel medesimo tempo conforme a quello del Card.le si servì in casa di m.s Dario Tarugi per il Duca Gaetano con 5 gentiluomini e suoi servitori che sbarò con detto Cardinale e l'intertenne m.s Iacomo Garaltieri. In tinello mangiorno da 24 servitori del Cardinale con carne e polli: Et il medesimo servizio si fece la sera se bene alla seconda tavola furno pochi, perché erano tornato a rimbarcarsi.
Il dì 16 da sera venne in Livorno il S.r Oratio dal Monte chiamato da S.A. che si spesò da noi con sei gentiuomini al suo alloggiamento con un piatto con due volatie et al tavolino [cr]ebbono da otto gentiluomini che si son fatti tre piatti con volarie per cinque pasti.
Il Cardinale doppo desinare andò dal Gran Duca e negoziò assai et alla sera se li dette cena, ma lui volse solo collazione in camera, et il S. Don Gio. cenò con li sua prelati nella solita sala. Doppo ciena venne da lui il Gran Duca e vi stette assai et alle 7 ore in circa accompagnato dal S. Don Gio. Ecc.mo si andò a imbarcare con li schifi e fregate

[1] Cf. ASF, Guardaroba medicea Diari di Etichetta, 1, p. 110.

von molte torcie e paggi e se li mando in galera un regalo di dispensa notato in q.to 91 oltre ad altre robbe mandate dalla guardaroba che tutto si consegnò al suo mastro di casa e se li dette la notta // di quanto era nelle casse e barilli e tutto.
Il dì 18 doppo desinare partrino licenziati da S.A. il S. Oratio dal Monte e sua truppa e li altri gentiluomini venuti di Firenze e di Pisa.
Il predetto Cardinale va a Spagna inquisitor maggiore.

Capitolo II

Descriptions of Guidobaldo's life

The present chapter exposes important biographies of Guidobaldo: the first section presents the transcription of Baldi's account of Guidobaldo's life in *Cronica de' Matematici overo Epitome dell'istoria delle vite loro*, the second reports the biography contained in BOP, ms 758 which is crucial for practically all later descriptions of the Marchigian mathematician's life. Section II.3 transcribes Mamiani's *Elogio storico*, the following one (II.4) the entry of Domenico Bonamini's "Abecedario degli architetti pesaresi", and the final section reports Guidobaldo's biography contained in P. Litta's *Famiglie celebri italiane*.

II.1 Baldi's account of Guidobaldo's life and work in *Cronica de' Matematici overo Epitome dell'istoria delle vite loro*

While Baldi's extensive *Vita* of Guidobaldo seems to be lost, some information about him is contained in the former's *Cronica de' Matematici overo Epitome dell'istoria delle vite loro*.[1] The entry about Guidobaldo (pp. 145-147) is the last one of the work that had been finished in 1596, but published only in 1707.
The information that Guidobaldo was living in isolation at Monte Baroccio ("Vive egli ritirato in Monte Baroccio suo castello") refers to the 1590s, when his relation to the Duke of Urbino had already deteriorated drastically.[2] Yet, it had often been interpreted as if it referred to his whole scientific activity: as the documents collected in the context of the present doctoral thesis testify, this interpretation does not hold in reality.

Guidobaldo[3] de' Marchesi del Monte, figliuolo di Ranieri, la cui

[1] Cf. B. Baldi, *Cronica de' matematici, overo epitome dell'istoria delle vite loro*, Urbino, Monticelli, 1707.
[2] Cf. Appendix I, I.5.
[3] *in marg.* 1596

famiglia discende dalla Casa regia di Borbone, vive oggi famosissimo per l'eccellenza del suo ingegno nella professione delle Matematiche. Ha egli buona cognizione delle due lingue megliori, e delle cose filosofiche e della teologia.
Nelle Matematiche poi ha genio così grande, e particolarmente nelle cose della geometria e delle // subalterne, che pare che sia risorta in lui la vivacità dell'ingegno d'Archimede, il che ha mostrato ne' libri delle *Mecaniche*, ne' quali chiaramente appare ch'egli abbia tornata quella facoltà nel suo antico splendore.
Scrisse anco le dimostrazioni de' *Planisferii* e non ha molto publicò una dottissima *Parafrasi* degl'*Equeponderanti* d'Archimede tradotti da lui dal greco nella lingua latina. Scrisse anco, e fece stampare un libretto della correttione dell'anno e dell'emendatione del calendario, nel quale mostrò quanto esso vaglia ne' computi astronomici. Ora ha per le mani molte opere, delle quali una gran parte è per mandare in luce; queste sono un gran libro de' canoni celesti, ne' quali insegna per via di compasso a trovar tutte le questioni, che appartengono al primo mobile. Ha scritto parimente un libro intorno alla *Coclea* da inalzar l'acque, nelle quali rende la ragione e dimostra l'effetto di quel meraviglioso instrumento. È anco per dar fuori un grandissimo volume di *Perspettiva*, nel quale senza alcun dubbio si tiene che abbia da superare quanti altri hanno scritto intorno quel nobilissimo suggetto. Vive egli ritirato in Monte Baroccio suo castello, ove attendendo a studiare et a scrivere, vie//ne facendo ricco il mondo de' parti del suo felicissimo ingegno, e mostra d'esser stato degno discepolo di Federico Commandino. Molte cose sariano da esser scritte in questo felice ingegno, ma ci contentiamo di tanto per non uscir da termini che ci presc<r>ive la natura di questa historia.

II.2 Manuscript 758 of the Biblioteca Oliveriana Pesaro

BOP, ms 758 seems to be *the* fundamental account of Guidobaldo's life which was used by practically all later biographies.[1] It presents the information about the life and work of the Marchigian mathematician in the form of a questionnaire: it might have been composed in the context of Baldi's intention to write a *Vita* of his teacher.

[1]For example, G.B. Almerici's seems to have largely copied from BOP, ms 758 for his biography of Guidobaldo, contained in the "Spogli" (BOP, ms 455 fols. 293v-295r). This seems to be valid also for Bonamini's account, contained in the "Abecedario degli architetti e pittori pesaresi".

The document in question is a copy of an original documents that does not seem to be extant any more. Despite of its reliability in most cases, it contains also some imprecisions – testified by independent sources, collected in the context of the present doctoral thesis. Further, also the copyist seems to have introduced some errors: the most meaningful example is the confusion of the reported, wrong date of "1586" with the right one of "1606" as year of Guidobaldo's serious disease that led, in the course of few months to his death (cf. 11th question).

Probable period of compilation

Relevant for the question of the reliability of the text seems to be also the date of its composition: in fact, it seems that the biography was written *before February 1609*, or anyway before August 1614, i.e. shortly after Guidobaldo's death.
This dating bases on the identification of "Monsignor di Pesaro" with Cesare Benedetti in the fifth answer: in fact, the text reads:

> Ebbe poi anco caro il conversar con i più rari professori di queste scienze matematiche, fra quali furno Mons.r Vescovo di Pesaro, il S.r Federico Bonaventura, il S.r Mazzoni, il S.r Abbate di Guastalla, il S.r Galileo Galilei, et il S.r Piermatteo Giordano, uomini di eccelse valore.

As the precedent chapters have shown, Benedetti was one of the closest interlocutors of Guidobaldo, and from 1586 bishop ("Monsignore") of Pesaro. He died on February 6th 1609.[1]

Even it these identification should not be valid, there is another element that permits to date the biography: a *terminus ante quem* is August 1614.
In fact, the seventh question reports that Guidobaldo had "eleven sons, of which seven reached adolescence, and now six are alive". In this context, it is known that his son Carlo dal Monte died in 1603 as soldier in Flanders. The next son of Guidobaldo who died was Orazio dal Monte, in August 1614. His other sons, Francesco Maria (II), Alessandro, Onofrio, Uguccione and Giovanni lived longer.

Transcription

Primo si domanda con quale occasione e titolo il S.r Raniero <dal Monte> s'accostasse alla servitù del Duca Guidubaldo <II della Rovere>.[2]
A questo si risponde che il S.r Gironimo de Marchesi dal Monte allora Marchese dal Monte avendo accomodato il S.r Carlo suo primo figlio con Papa Paolo III per suo coppiere (quale da S. B.ne fu tanto amato che S.S.ta istessa nella sua

[1] Cf. BOP, ms 966, pp. 138-139; see Appendix II, II.2.
[2] The emphases of the questions are ours.

infirmità che ne morì poi, gli disse chiaramente che s'ei guariva lo voleva fare cardinale) mandò il S.r Raniero di età di undoci anni al servizio del suddetto Sig. Duca Guidubaldo per suo paggio nel quale servizio fu così grato a S.E. che cresciuto negl'anni maturi fu continuamente da quella portato inanzi per tutti i gradi maggiori della corte e dello stato perché nella corte lo onorò dei più principali titoli e dello stato gli diede tutte quelle cariche che più erano importanti.

Secondo si domanda per qual cagione e quando avesse il castello di Monte Baroccio.
La cagione fu che egli mentre veniva tanto amato et onorato dal S.r Duca si portò sempre con tanta fedeltà e tanto amore che da tutti universalmente e singolarmente si rese amabilissimo, onde il medesimo S.r Duca avendo a core la persona sua si compiaque onorarlo ancora di titolo di Conte e gli donò il detto castello. Il tempo fu nell'anno 1543.

Terzo si adimanda come, con chi si accasasse, quanti figli e figliole avesse.
A questo si risponde ce l'istesso S.r Duca l'anno doppo che gli donò il detto castello lo acasò con una figlia unica di eredità della seconda moglie del S.r Cavaglier Pianoso gentil<u>omo pesarese e ricco di grandi facoltà, che fu del '44. Dalla quale in capo lìanno ebbe il suo primo figlio, il S.r Guidubaldo, ebbe nove figlie delle quali tre furno monache e l'altre furno maritate. Una nel S.r Ott.no Fregoso, figlio del S.r Aurelio Fregoso Sig.r di S.ta <A>gata, l'altra nel Conte di Piandimeloso che poi si rimaritò con la figlia in casa SS.ri Bentivogli, la terza in un figlio del Arcivescovo Tiranni, che ebbe prima moglia et era ricchissimo, la quarte nel S.r Francesco Beri gentilomo fiorentino parimente ricchissimo, et ebbe sei figli maschi per sé stessi noti al mondo, vivendo oggi Francesco Maria Cardinale e Federico.

Quarto, si domanda dove, quando, cioè in che anno, mese, dì et ora il S.r Guidubaldo nascesse.//
A questo si risponde che egli naque in Pesaro, l'anno fu 1545, il mese fu di genaro alli 11 il dì fu di domenica l'ora fu alle 12 e mezza in circa, et al suo battesimo fu comp.e l'istesso Sig.r Duca solo.

Quinto, si domanda quali maestri avessi di grammatica e di musica. E se mai fosse allo Studio di Padoa o altrove.
Il S.r Duca Guidubaldo per l'amore che li portava, volse che egli di età di 7 anni incirca si mettesse alla servitù del S.r Prencipe suo figlio magnando continuamente alla sua tavola, et essendoli sempre appresso. Nella quale età egli viveva sotto le discipline delli medesimi maestri del S.r Prencipe, e quello di grammatica si chiamava M.s Lodovico Corrado, di musica Paulo Animuescia, e Fra' Costanzo Porta de' minori osser.ti, tacendosi gl'altri di scrima e cavalcare in quei tempi famosi. Mentre che egli cresceva in queste discipline cominciò a darsi a gli studii delle Matematiche, per il ché di età di 19 anni andò a Padoa per lo studio della

filosofia, ma più vivamente attendeva alle dette Matematiche, et ivi trattenutosi un sol'anno se ne tornò alla corte al med.o servitio del S.r Prencipe come prima; né perciò desisteva punto dalli suoi incominciati studii, per il ché per suo maestro singulare ebbe il S.r Federico Comandino, quel tanto <u>omo, sotto le cui discipline proffittò di maniera come per le sue opere da lui lasciate si può vedere. Ebbe poi anco caro il conversar con i più rari professori di queste scienze matematiche, fra quali furno Mons.r Vescovo di Pesaro, il S.r Federico Bonaventura, il S.r Mazzoni, il S.r Abbate di Guastalla, il S.r Galileo Galilei, et il S.r Piermatteo Giordano, uomini di eccelse valore.

Sesto, si domanda se servisse e come, essendo giovanetto, il Ser.mo S.r Duca, se andasse con esso lui all'armata e se vi si trovasse.
Circa la servitù che egli ebbe in età giovanile con il S.r Duca Patrone del qui sopradetto si può cavare la risposta.
Circa poi se egli andasse con esso lui all'Armata e se vi si trovasse:
A questo si dice che essendo egli di fresco tornato dalla Guerre d'Ungaria alle quali v'andò d'età di 22 anni incirca con il S.r Aurelio Fregoso Signor di Santa Agata ch'avea carica di tremila fanti, trovata questa altra occasione // che il S.r Duca voleva intervenire nell'Armata e chiamare da S.A.S. al suo servizio se ne passò con esso in Sicilia, la dove in Messina soprapreso improvvisamente dalla sciatica non potè ritrovarsi nella giornata ma fu necessitato tornasse a casa così malamente infermo.

Settimo, si domanda di che età pigliasse moglie, quanti figli e figliole avesse.
Quando fece il sposalitio avea 14 anni, et il Duca Guidobaldo li diede per moglie una sua figlia direttissima naturale con molta dote, la S.ra Felice della Rovere, donna invero molto singulare e di diciotto ebbe il primo figlio. Secondo, de' figli ne ebbe undoci, de' quali sette sono arrivati all'età virile, et ora sei ne sono vivi. Delle figlie n'ebbe sei, et ora ne sono vive tre, una vedova et due monache.

Ottavo, quando gli venisse la sciatica e quanto li durasse?
La sciatica gli venne quando andò all'Armata come s'è detto e fu intorno agl'anni trenta della vita sua. E gli durò infine alla fine della vita, con tutto che per consigli dei medici di Padoa dove andò aposta a curarsi per liberarsene, bevesse sempre l'aqua che per esser stata gravissima lo tenne lungo tempo in letto e da poi talmente impedito che egli convene lasciar la servitù del S.r Duca e la Guerra, per il che si diede a tutto potere alli studii di Matematica.

Nono si domanda quante e quali opere scrivesse.
Di queste per esser il numero lungo se ne farà lista particolare e si mandarà.[1]

Decimo, si domanda quando fosse chiamato dal Granduca di Toscana,

[1]This kind of list is not present in the ms 758 BOP.

e come fusse veduto da quel Prencipe.
La prima volta quando S.A. lo mandò a visitare e rivedere tutte le fortezze e città dello Stato, e li diede il S.r Donato dell'Antella Comisario Generale, et de' SS.ri 48 di Fiorenza che lo accompagn<aron>o sempre e questo fu del 1588. L'altra, dal Granduca fu mandato a chiamare per le nozze acciò come caro a quell'A.za per averli allora fatto il fratello Cardinale intervenisse con lui e fu del 1590. E in tutte due le volte e per tutto fu spesato et allogiato da S.A. e li assegnò corte de' servitori con carozze e cavalli e fua accarezzato oltra modo, et interveniva ad ogni attione benché secreta, e sua A. lo menava spesso in cerchio // seco. E lo mandò a levare e porre a casa sua sempre con [l'etiche] sue principali.

Undicesimo, si domanda quando e di qual infirmità s'ammalasse e'l progresso della malatia e gl'accidenti. Quando e dove morisse? Dove sia sepolto? E l'epitafio?
Nel 1586[1] si infermò nel marzo, ma però volse celare il suo male, infine quando non potea più reggersi in piedi, che fu al principio di novembre, quando poi si allettò. La prima sua malatia fu il continuo bever aqua per guarire dalla sciatica, il che le cagionò una frigidità di stomaco tale che gli lo rese inabile in tutto alla digestione. Posto in letto il male diede in febre etica. Il progresso della malatia per doi mesi continui era una certa declinazione per la inapetenza de' cibi che lo veniva consumando a poco a poco. Et in quanto agl'accidenti della malatia non furono varii né novi perché ella fu sempre tale come s'è detto. E con tutto che l'Ill.mo Sig.r Card.le suo fratello gli mandasse da Roma acque e rimedii perfettissimi per lo stomaco. Non però cosa alcuna lo poteva giovare. Di maniera che dopo doi mesi continui di malatia nella quale fu sempre pazientissimo a dì 6 di genaro a ore incirca alle 19 e mezza se ne passò a miglior vita, che fu di sabbato il dì della Epifania. Morì in Pesaro et fu sepelito nel sudetto monastero del Corpus Domini, e la sua morte fu così sentita da tutta la città e dal Italia che fu onorato da molto virtuosi con varie poesie latine e volgari, et il S.r Canonico Gabellini li compose l'oratione funerale e fu accompagnato con quella pompa e splendidezza che si conveniva e che la città concedeva.
L'epitaffio è questo, che sia quanto si richiede per risposta delle undici domande.
D.O.M. Guido Ubaldo e Marchionibus Montis S. Mariae Montis Birotii Comiti II Artibus Egregiis, Scientiisque praesertim Mathematicis Eminentissimo cuius plaeclaras virtutes modesetia ornavit religio superavit. Qui santissime obiit exeunte aetatis super anno LXII, salutis MDCVII, VIII Idus Januarii.
Felix de Ruvere et Filii coniungi, et Patri optime marito. //

A questo si aggiunge che in tutta la vita sua giovenile, virile e senile ei fu sempre di così esemplare modestia e mansuetudine che per nessuna delle sue dote tanto di giochi quanto d'ornamenti nelle quali egli eccedeva molto suoi pari, non fu mai veduto altiero, e nelle conversazioni tanto d'amici, come di servitori non fu

[1] This date is surely wrong: it seems to have been copied badly from the right date "1606".

mai veduto alterato per grande occasione che se gli prestasse, né dalla sua bocca fu mai udita parola non mere, che onesta nonché scandalosa. E fu di così bona e santa vita che in tutte le feste principali dell'anno si comunicava e ciò faceva per il continuo ogni otto giorno, massime verso l'età senile, e la notte inanzi la comunione la vegliava tutta in oratione et ogni venerdì si disciplinava, seben questo tralasciò per persuasione dell'Ill.ma Sig.ra Felice sua consorte come zelosa della sua sanità e vita. Compose inoltre doi libri spirituali. Uno sopra il Pater noster e l'altro sopra l'Ave Maria, gli esemplari de' quali si conserva appresso l'istessa Ill.ma Sig.ra Felice. E le copie d'essi si leggano da molte persone religiose monache capucini, la religion' de' quelli egli sempre osservò con molta riverenze e ne fu somamente devoto.
Nelle cose poi del mondo non ebbe molta fortuna e ne' suoi travagli era tanto patiente, che non si distingueva in lui per turbatione dello stato, siché il suo nassere, vivere e morire è stato nella suddetta città di Pesaro.

II.3 Mamiani's *Elogio storico* on Guidobaldo

Mamiani's *Elogio storico* on Guidobaldo covers the pages 45-87 of G. Mamiani, *Elogi storici di Federico Commandino, G. Ubaldo del Monte, Giulio Carlo Fagnani, letti all'Accademia pesarese dal Conte Giuseppe Mamiani*, Pesaro, Nobili, 1828. The numerals in parenthesis, contained in Mamiani's text, refer to the internal endnotes, reported at the end of the eulogy.

ELOGIO STORICO DI GUIDO UBALDO DEL MONTE

Letto all'Accademia Pesarese da G<iuseppe> M<amiani> Vice-Segretario della medesima

Bello e avventurato quel giorno in cui a cittadina e dotta adunanza di favellare è concesso lodando alcuno de' suoi più famosi concittadini. Esempio non raro di patria carità fu codesto; mentre sappiamo che i savi reggitori delle greche e romane repubbliche a scopo de' loro fini politici se lo proposero. Ond'è che io mi tengo oltre ogni dire onorato, e dall'occasione di ragionale in faccia vostra o accademici, e dal riflettere che, sarò per dirvi l'elogio di un uomo nelle scienze eccellente, il quale nacque e visse e grande addivenne fra le mura di questo patrio comune. Che se da maraviglia presi sarete in considerando come io povero di mezzi, e quasi scemo di facondia ardisca cotanto, certo che non avrete ad istupire come questa Pesaro nostra abbia dato al mondo scientifico un uomo di tanta fama quale si fu il marchese Guido Ubaldo Del Monte; dappoiché voi sapete essere tutta propria di lei la dottrina, e la feracità degli ingegni. Né già crediate che io voglia arrossire tributando al mio paese cotali encomii; ch'essi gli sono dovuti, se dagli estranei gli vengono concordemente dati; e saria piuttosto tacendo da riferirsi a

viltà, quello che non tacendo si volesse pur da taluno ascrivere a superbia. E in vero che l'obbligo ci corra dì mantener viva la fama di colta cittade a Pesaro, è manifesto dal considerare che in tutte l'età e in tutti i generi di studio ella seppe illustrarsi. Valganmi a provarlo i nomi italici di un Angeli, di un Norsini, di un Macigni, di un Belluzzi, di un Soperchi, di un Tommasi, di un Sentinelli, di un Olivieri, di Gio-Andrea Lazzarini, di Giulio Perticari; e valganmi assai più i molti nomi Europei, quali sono quelli degli Acci, dei Collenucci, degli Arduini, dei Postumi, dei Simoni, dei Diplovatazii, dei Leonardi , di Gioanni Battista Zanchi, di Omero Tortora, di Giovanni Paolucci, di Gio-Battista Passeri. Venga di fatto chi ci domandi filosofi o leggisti; chi ci richieda medici, o poeti; chi faccia buon viso a' filologi, ed a numismatici; chi si diletti delle fisiche o delle istorie naturali; chi tenga in pregio le arti belle, chi preferisca le militari e le politiche; chi delle istoriche cose si giovi; chi di colta favella italiana o latina si onori: noi potremo ad ognuno soddisfare; noi sapremo apertamente dar prova non già di mediocre, ma di sublime valore. Ed oh! Pur fosse al sommo Facitore piacciuto che più lunga vita si concedesse a quell'acuto, e gentile intelletto del Perticari! Che già non saremmo a tale venuti da procacciargli per tutta Italia l'onor del sepolcro, ma ben egli avrebbe saputo, come il celebre Passeri trovar posto e simulacro fra gli uomini sommi dell' Inghilterra; o fama inarrivabile presso tutti gli Atenei dell'Europa, come colui che a somiglianza del costruttor d'Amfione ha pur tratti al suo volere gl'ingegni più difficili e si è meritato il nome di Orfeo Pesarese. Ma se di tanto possiamo a giusta ragione gloriarci, perché non imprendiamo una volta a trarre dall'oscurità in che si giacciono le opere di tanti illustri concittadini che pur sudarono al nostro incremento, e che ne' loro libri ci lasciarono aperto testimonio di quell' affetto che per noi gli animava? La gloria loro, dirò col Giordani, è come una eredità nostra, e il mantenerla e propagarla è nostro interesse; e di tramandarla a posteri non possiamo o senza empietà scansarci, o senza viltà sconfidare. Ecco adunque il perché, seguitando io nel già intrapreso costume di lodare istoricamente ora l'uno ora l'altro dei più rinomati fra i dotti di questa Metaurense Provincia, voglio che oggi al Del Monte si paghi il debito della gratitudine. Per tal guisa verrà fatto che si ammiri, e s'innalzi quell'uomo il quale ci mantenne le matematiche scienze e care ed onorate, facendole anzi a vantaggio di tutti progredire; come io brevemente, e per quel meglio che qui si possa cercherò di mostrare.

Guido Ubaldo del Monte venne da una delle più illustri famiglie italiane; sicchè al dire di Bernardino Baldi (1) dalla regia casa di Borbone discese. E per quello che l'Atanagi ne conta (2), Raniero del Monte figlio di Girolamo e d'Ippolita Sforza de' Conti di Santa Fiora vedova di Federico Farnese, fu primo a recarsi di Perugia in Pesaro; ivi padre addivenne del lodato G. Ubaldo, e del card. Francesco Maria; dal duca G.U. II di Urbino fu donato del feudo Mombaroccio nell'anno 1542, salutato nobile romano, capo delle lancie spezzate, generale delle battaglie, governatore di Pesaro. Poscia nell'anno 1544 ebbe in isposa dal suo signore la figlia del cav. Pianoso, e questa gli partorì alli undici di gennaio del 1545 l'oggetto

de' nostri encomii (3). Per la qual cosa è manifesto prima, che la famiglia di G. Ubaldo non può trasmutarsi in quella dei duchi Rovereschi, come già venne fatto per opera di qualche oltramontano; se pure non fossegli stata occasione e la simiglianza del nome, e i vincoli del sangue che al duca G. Ubaldo II la strinsero allorché in moglie dava al nostro Del Monte una sua figlia per nome Felice (4): secondo che non debbesi star col Montucla quando asserisce (5) essere ignota 1'epoca del suo nascimento e quella del suo morire; e né tampoco col Tiraboschi che al sentimento s'unisce del citato Montucla (6); posciacché se egli stesso assegna il tempo della morte al principiare del secolo decimosettimo e precisamente nell' anno 1607, noi già vedemmo fissato quello del nascer suo all'anno 1545; e ciò confermasi dalla mortuaria iscrizione (7) che si rende opportuna per ammendare l' errore incorso nel saggio del celebre Bossut che il fe' nascere nel 1533, e morire nel 1617 (8). Ma ben altre cose da noi attende quell'uomo grande; che nato di padre dottissimo e nelle scienze sublimi versato, tanto che valse a pubblicare due libri d'architettura militare (9), si diede a guadagnar l'animo del principe Francesco Maria, a convivere seco lui dimesticamente e ad erudirsi per opera de' celebri maestri Lodovico Corrado, Paolo Minuccia, Fra' Costanzo Porta. Andò d'anni 19 allo studio filosofico in Padova, ove applicò l'animo alle matematiche; ed in patria tornato le seguitò nella scuola di un Commandini insieme ad un Torquato Tasso (10). Quindi conversò coi più dotti di quel tempo, quali furono Cesare Benedetti vescovo di Pesaro, Federico Bonaventura da Urbino, Bernardino Baldi abbate di Guastalla, Pier Matteo Giordani da Pesaro, Galileo Galilei. Passava in Ungheria col Fregoso, e contra i turchi col principe Francesco Maria combatteva; sicché infermatosi a Messina non intervenne alla celebre giornata de' Curzolari. Ma nell'anno 1588 fu eletto a visitator generale di tutte le città e fortezze del gran ducato di Toscana, e visitolle di fatto in compagnia di Donato dell'Atella commissario; locchè prova essersi in questa parte di matematiche applicazioni addottrinato, ed avere per tal guisa mantenuta viva la nominanza che la scuola d' Urbino erasi già da gran tempo acquistata. E voi ben vedete accademici, ch'egli oscurissimo non vivea, come il Tiraboschi (11) ed il Montucla (12) asseriscono; o che solo più tardi avrà voluto godere de' begli ozii di pace ne' suoi feudali recessi, dove quasi sepolto quei due storiografi ce lo dipinsero. Come egli ponesse a profitto e l'agiatezza di sua condizione, e il conforto della solitudine io debbo innanzi tratto addimostrare.

Scrisse da prima sulle meccaniche (13) un nobilissimo trattato, che dal latino in volgare converse il Pigafetta, e fu dedicato a Giulio Savorgnano dopo che vide la luce in Venezia presso Francesco de' Franceschi Senese[1], e presso Evangelista Deuchino. Poscia a più elevate cose poggiando, diè mano ad una teoria completa de' planisferi celesti (14), ad alla correzione de' cicli (15): quindi tornò su quell'aureo libro Archimedeo che tratta delli equiponderanti, e questo maestrevolmente si diede a parafrasare, come che intricato alcuna volta ed oscuro (16): di

[1]Senese *correxi ex* Sanese

prospettiva distese sei libri con una fecondità di principii ed una somma tale di conoscenze matematiche, ch' ebbe nome per questo di uomo eccellente (17): e al cielo nuovamente guardando pur volle pratticamente insegnare le ragioni celesti, e farci ricchi di sette libri ripieni di problemi astronomici, e di insegnamenti cosmografici da disgradarne qualunque gli si fosse in quella età reso compagno parlò finalmente sulla coclea, argomento di tanto peso a quell'epoca, e di tanta lode cagione (19). Le quali opere furono dal Santini pur nominate, ed esistono per la più parte nelle varie biblioteche della nostra Patria: ma le meglio conosciute sono i libri delle meccaniche, quelli della vite Archimedea, e della prospettiva; opere di fatto meritevoli d'un più serio riguardo, e come tali citate dal Montucla, dal Bossut, dal Tiraboschi, dall'Andres, e da tanti altri, che troppo tedio sarebbe il riferire. A me peraltro è tocca la bella sorte di rinvenirne due, di picciola mole è però, ma non di lieve interesse, le quali sono un bellissimo commentario al quinto libro Euclideo, ed mi leggiadro opuscolo sulla proporzione composta; e queste si stavano polverose, ed ignote fra i molti libri degli eredi Giordani. Io farò motto delle più grandi ed eccellenti; che a ragionare di ognuna mancherebbe e il tempo e la lena; ma pria fa d'uopo avvertire in qual secolo G. Ubaldo scrivesse, e di quali scientifici lavori poteva aiutarsi.

Perciò che spetta ai matematici suoi predecessori, voi ben sapete che i primi elementari insegnamenti d'Euclide, d'Archimede, d'Appolonio; le opere quanto estese altrettanto implicate d'Ipparco e di Tolommeo; quelle di Eudosso, Eratostene, Possidonio, Anassimandro in parte offese dall'ingiurie del tempo, e in parte confusamente raccolte o tramandate per mano degli arabi, erano i modelli più rari e ì più grandi soccorsi matematici d'allora. Le fatiche di un Leonardo Pisano, di un Giordano Nemoriano[1], di Purbac, Regiomontano, Walter, Cardano che a lui furono d'appresso, per quanto si vogliono o si deggiono magnificare , erano però sempre frutti di secoli i meno dotti, e inevitabile sequela di male intesi principii. Clavio e Tartaglia, che fra i matematici di quel tempo ebber' fama d'illustri, ad imparziali giudici appariscono manchevoli, oscuri, ed inesatti. Arroge che i loro scritti furono prodotti alla luce contemporaneamente a quelli di G. Ubaldo; ond'è che forse di molti e molti non avrà avuto contezza quella mente sublime, che pur grande in se stessa, di grandi mezzi avea d'uopo per lo scientifico incremento. Federico Commandino suo precettore venne chiamato il matematico eccellentissimo; e certo ch'egli poté onorarsi di avere sì dotta scuola allevata, di essere stato il primo a far risorgere le matematiche in Italia, di aver posto sublime fra i Muzi Giustini , gli Antoni Galli, i Bernardi Capelli, i Pietri Bonaventura, i Dionigi Atanagi ch' erano fregi rari e bellissimi della corte Urbinate. Ma il Commandino limitossi ai volgarizzamenti de' greci, al centro gravifico de' solidi, a qualche problema prospettico ed astronomico; quando per lo contrario il Del Monte abbraccio tu li a quanta la scienza fisico-matematica di quel tempo, e sette opere originali ci diede. Di Leonardo da Vinci, il quale come asserisce il Venturi

[1]Nemoriano *correxi ex* Hemoriano

nelle giunte al secondo volume del Montucla (20) ragionò in meccanica secondo i veri principii delle forze e dei pesi applicati obliquamente alle braccia di una leva, dei piani inclinati, e del movimento dei pendoli, noi con certezza sappiamo essere state le più belle idee matematiche sepolte per varii secoli ne' suoi manoscritti, e non avere perciò recato al Del Monte il menomo giovamento.

E volendo in principio favellare di sue cose inedite, la prima è un opuscolo in foglio di 55 pagine scritte dall'autore medesimo, (come risulta dal confronto fatto con alcune sue lettere esistenti nella Biblioteca Oliveriana), e col quale intende a dilucidare il quinto libro di Euclide, che egli stima l'ottimo fra gli scrittori di queste materie, e nel quinto lo predica per prestantissimo circa alla chiarezza ed alla distinzione degli oggetti; onde è che asserisce essere questo libro fondamento di tutta la geometria elementare, e perciò non volere mutarne l'ordine, ma solo commentarne i passi più importanti – neque secundum propriam sententiam Euclìdem facere, intentio nostra est. Volumus enim ut Euclides, Euclides remaneat – (21). E perché i commenti di Federico Commandino erano e sono tenuti per i più fedeli, chiari, ed ordinati di que' tempi, così quelli si propone seguire: e coi medesimi paragonerò io questo lavoro meritevole di ogni elogio. Il Del Monte pertanto volendo scrivere sugli elementi della geometria scelse il libro di maggiore importanza, e segui passo passo il suo maestro, riconoscendo in lui pregi non comuni, o superiori a tutti gli altri di quella età.

Per dare poi alla scienza qualche cosa di nuovo, e specialmente per istruirne gl'indotti, dilucida ed amplifica sul principio le definizioni dalle quali dice resta appianato il sentiero, non perdendo mai di vista l'ordine e la connessione delle medesime, che veramente è quivi ammirabile ed utilissima. Quindi le venti definizioni d'Euclide mette in chiaro lume: e dove il Commandino non ne commenta che alcune di volo ed altre lascia inesplicate, G. Ubaldo si fa a trattarle distintamente, e supplisce in ispecial modo al Commandino per quello che spetta la ottava e la nona sull'analogia, o simiglianza di ragioni; la duodecima sulle quantità omologhe; la diecinovesima sull' analogia ordinata; e la ventesima sulla perturbata. Io non istarò qui a descrivere l'esattezza con cui nota la generalità delle prime, dove Euclide adopera il vocabolo di grandezza per applicarla poi a qualsivoglia genere di quantità; la necessità di calcolare la forza delle equimoltiplici; la conoscenza esatta della proporzione, vale a dire il mutuo stato di due grandezze dello stesso genere, perciò che risguarda la quantità escluso sempre il paragone di finito a infinito; il modo di distinguere quando quattro grandezze abbiano la stessa ragione, "vale a dire il conoscere che cosa sia proporzione, quali siano le grandezze proporzionali, quali abbiano fra se una uguale, maggiore, o minore proporzione; la dettagliata spiegazione dell'analogia; la necessità di tre termini per costituirla; la forza delle permutazioni, delle conversioni, e delle composizioni. Nelle quali materie egli raddoppia gli esempi; fa il paragone coi numeri, e mostra la necessità di parlar sempre di quantità dello stesso genere, non tralasciando di osservare come Euclide conservi l'ordine naturale delle cose, quali dati egli assuma, in quali luoghi degli altri libri applichi le definizioni di questo, che è

scorta verace di quelli. Che se paragonare vogliamo questi commenti con quelli del Commandino, io trovo che G. Ubaldo oltre ad una maggior chiarezza ed estensione unisce il pregio di analizzare sempre lo spirito di Euclide, e far vedere la connessione dei principii da lui dimostrati; metodo utilissimo ai giovani e necessario a tenersi in codesto libro.
Passando ai teoremi, egli ne dilucida venticinque: fa vedere che questi soli ad Euclide pertengono, non curandosi delle giunte di Apollonio e di Archimede, collazionate da Pappo; giacché si propose di non accrescer per nulla[1] a quanto Euclide avea scritto. Avverte qui che il greco autore mantiene nei teoremi l'ordine osservato per le definizioni, trattando prima su i multipli ed equimultipli, poscia sulle proporzioni, e in fine su i vari stati di quelle. Palesa la distinzione che convien fare per le quantità pertinenti a generi diversi; l'uso della decimaquarta proposizione che può servir di lemma alla decima sesta e decimaottava; la inutilità di una particolar menzione fatta dal Commandino sulla decimanona, riguardo alle ragioni sesquiterzie, e sesquialtere, mentre Euclide la fece comune a tutte. Indica l'interpretazione del – quae binae summantur et in eadem proportìone – per l'analogia ordinata che, come si riporta nella decimanona definizione, significa: tre grandezze con altre dello stesso numero essere fra loro in ordinata analogia. Rende manifesta l'applicazione del teorema vigesimoprimo come lemma del vigesimo terzo; la necessità in cui si trovò Euclide di non collocare il vigesimoquarto fra il decimo e decimoquarto teorema, dove l'avrebbe richiesto la materia, ma bensì dove per la sua intelligenza necessitava la dimostrazione del vigesimo secondo; e finalmente la chiarezza, l'ordine la sublimità dell'autore, da cui tutti han dovuto ritrarre le fondamenta dell'elementar geometria, involuta da prima, e cavillosa, specialmente rispetto alla sublime teoria de' rapporti e delle proporzioni.
Commentansi dal Commandino dieci teoremi; laddove G. Ubaldo tutti dilucida, ma diffusamente poi l'ottavo, il decimonono e il vigesimoprimo, come più interessanti e più meritevoli di un'analisi particolare. Il Commandino varie volte si limita alla sola interpretazione del testo greco, e all' induzione di alcuni corollari; mentre G. Ubaldo curandosi solo della materia trattata da Euclide, la sviluppa, la chiarisce, e non manca pur egli di trarne le opportune conseguenze, nelle quali va dietro all' autore e fa apprezzare le ascose verità che dalle stesse sue dimostrazioni ampiamente derivano. E fa d'uopo ammirare la somma precisione nel richiamare in margine le proposizioni antecedenti, nel mantenere le stesse indicazioni di lettere e di numeri dall'autore adoperate, nella cura presa onde il giovane conosca lo spirito delle proposizioni, e riassuma opportunamente il filo; la qual cosa ommette quasi sempre il Commandino, ed anche allora quando il soggetto la chiede per essere o implicato od oscuro. In somma egli è questo un commento ragionato, proficuo, e non comune, che a petto dei moltissimi di quei tempi porta in se il carattere di uno scrittore filosofo e di un profondo indagatore delle utili verità; questi è un commento che quando si fosse esteso agli, altri libri del Megarese, otterrebbe un

[1] nulla *correxi ex* nnlla

applauso generale dai dotti, darebbe un incredibile facilità d'intendere il celebre autore, e pubblicato a nostri giorni potrebbe gareggiare con qualche coreo sintetico dei moderni.
Ma quanto si disse circa al primo opuscolo, altrettanto dobbiamo ripetere e a più buon dritto pel secondo, il quale tratta della proporzione composta: opuscolo di venti pagine e del carattere del primo, ma in vari luoghi corretto, ed ampliato con delle annotazioni e aggiunta riportate in margine. Ognuno sa di qual peso sia nella geometria elementare la proporzione composta; e quanto su di essa abbiano scritto i greci e i latini matematici. Il perché di un gabinetto così degno volle favellar G. Ubaldo, ma limitossi a trattarlo per ciò che riguarda il senso della quinta definizione del sesto libro di Euclide, e della vigesimaterza proposizione del medesimo. – Qui quidem sensus ab omnibus praestantissimis mathematicis eodem modo acceptus fuisse videtur (22) – Fu dunque inteso a dichiarare cosa significhi una proporzione composta, e come la definizione sopradetta del sesto libro di Euclide abbia a servire di rigorosa dimostrazione per la vigesimaterza proposizione.
La quinta definizione è la seguente – Proportio ex proportionibus componi dicitur, quando proportionum quantitates inter se moltiplicatae, aliquam efficiunt proportionem – dove G. Ubaldo dimostra che Euclide, parlando in genere di quantità, ha voluto considerare tanto i numeri che le grandezze. E che siccome, date almeno due ragioni, dalla loro moltiplicazione nasce la ragione composta, così dati i quattro termini d'una proporzione, si potrebbero avere, secondo questa definizione, tre prodotti, cioè dell'antecèdente col conseguente reciproco, degli antecedenti, e dei conseguenti fra loro tanto per i numeri che per le linee; ma che così non va intesa geometricamente, e solo nel modo espresso nella vigesimaterza proposizione che è la seguente – Aequi angula parallelogramma inter se proportionem habent ex lateribus compositam.
Di fatto ogni qualvolta il lato dell'uno sia l'antecedente, e il lato dell' altro il conseguente nelle figure equiangole (siano esse rettangolari o no), si avrà sempre la proporzione composta dei loro lati; e si dissero le equiangole, giacché senza questa circostanza non si avrebbe la richiesta disposizione dei lati stessi. Che poi i rettilinei equiangoli debbano sempre avere la proporzione composta dei loro lati, sebbene già provato da Euclide, G. Ubaldo lo mostra con un'apposita elegante dimostrazione. E se a tre termini si riduce codesta proporzione dei lati, fa conoscere manifestamente il Del Monte che ciò non oppugna al senso della definizione, ma che anzi esprime realmente la moltiplicazione delle due ragioni, da cui nasce la ragion composta che hanno fra loro i rettilinei equiangoli. Come poi sia giusta la riduzione a tre termini, e come questa sia vera proporzione composta; come Euclide l'abbia unicamente espressa nel sesto; e come a lei non pertengono le definizioni del quinto che notano soltanto l'aggregazione dei termini; come la prova della ragione composta nei rettilinei si riferisca alla definizione stessa; tutto dimostrasi esuberantemente da G. Ubaldo in quattro e più pagine. Alla decima chiarisce il senso con cui va intesa la disposizione de' lati per la

proporzione composta nei rettilinei, cioè quando sono costruiti dagli antecedenti l'uno, e dai conseguenti, l'altro – et non aliter; tunc enim eorum proportio inveniri potest, quae quidem componitur ex primo ad secundum, et ex tertio ad quartum (23) – giacché prova che Euclide stesso quando disse – proportionem componi ex proportionibus – intese, che siccome nelle proporzioni esistono gli antecedenti e i conseguenti, così dalla moltiplicazione degli uni e degli altri nasce la composta; e dice che in tal guisa l'interpretarono Archimede, Pappo, e Apollonio, l'ultimo de' quali appoggiò tutte le dimostrazioni delle coniche alla proporzione composta – quae est utique locus mathematicus praestantissimus, et ad inveniendas multarum rerum mathematicarum breves demonstrationes aptissimus – (24).
In prova di che G. Ubaldo si accinge a darne varie applicazioni: e in sulle prime trova la proporzione fra due triangoli (che l'hanno composta delle basi e delle altezze); quella di due parallelogrammi equiangoli; l'altra di quattro linee delle quali si formano; poscia la spiegazione dei luoghi apolloniani nella 2., 12, e 13 del primo libro; quali tutte sagacemente dimostra, e con metodo uniforme. Quindi con questa unica proposizione prova la decimaquarta e decimasesta del sesto di Euclide, e l'estende a qualsivoglia figura rettilinea ridotta in parallelogrammo, ed a qualunque solido rettangolare che sta ad un altro in ragion composta delle basi, e delle altezze; dimodoché conchiude – Ex dictis, etsi perpaucis quid sit proportio ex proportionibus composita, nec non quanta sit huius loci ubertas perspicuum esse potest, qui quidem ad alia multa inveniendo demonstrandaque aptari poterit. Quare hunc inter mathematicarum rerum praeclariora praestantioraque loca costituendum esse nemo ambigere potest – (25). Ed ecco rese per lui aperte le ragioni onde con tanta chiarezza ed eleganza vi si diffuse. Se paragonar vorremo quest'opuscolo con quanto dice il Commandino circa alla proporzione composta, vedremmo che questo è un trattato, e quello un commento. Ma se inoltre vogliamo avere d'innanzi gli scritti elementari de' suoi contemporanei, io non so vedere chi di tale materia parlasse tanto estesamente e con tanta maestria; ond'è che sì elegante lavoro deve per unico ritenersi, e noi dobbiamo veramente ringraziare gli eruditi di Pesaro che hanno e salvati, e custoditi gli scritti di questo celebre uomo.
Seguitando ora per le Meccaniche, è forza indicar sulle prime quello che dottamente ne scrive l'Abbate Andres al tomo decimo dell'opera sua. Per vedere (dice egli) la meccanica trattata come scienza esatta, ed illustrata con nuove teorie; bisogna discendere al secolo decimosesto; e cita a tal uopo le opere imperfette di Eutocio, Pappo, Boezio, Gerberto, e tante altre a quell'epoca esistenti. Ma il primo, (soggiugne egli) che potesse in qualche modo guadagnarsi il nome di meccanico, altri non fu che il marchese G. Ubaldo del Monte, il quale non solo sparse alcuni bei lumi a su questa materia ne' comenti dell'opera degli Equiponderanti d' Archimede ma ne' propri suoi libri, imbevuto come egli era della dottrina d'Archimede e di Pappo, cominciò a colpire nelle vere ragioni dei fenomeni meccanici, ed a mostrarsi meccanico. Allor si può dire che incominciò a risorgere quella scienza. Egli impiegò il metodo (dice Montucla) dagli antichi meccanici

adoperato, di ridurre cioè tutte le macchine alla leva, applicandola felicemente ad alcune potenze meccaniche, ed in ispecie alla puleggia. Fu il primo a considerare esattamente la bilancia, e intenderla nella sua vera natura col proporre i tre centri tanto da poi conosciuti, del mondo, della gravità, e della bilancia medesima; dalla varia collocazione dei quali ultimi due, tutti derivano i casi cui si riferisce quest'istromento; come 1'autore distintamente avvalora per le quattro prime dimostrazioni di questo libro. Ed a proposito della quarta proposizione che è la seguente – la bilancia ugualmente distante dall'orizzonte, e che abbia nell' estremità delle braccia pesi uguali ed equidistanti dal centro collocato in essa, se verrà mossa o no, dovunque sarà lasciata rimarrà – fa d'uopo sapere, dietro la scorta del saggio Montucla, che qui egli dimostra e distingue quanto negato e confuso aveano tutti gli scienziati suoi predecessori. Fa d'uopo sapere che Cardano e Tartaglia medesimo erroneamente risposero alla proposta (mistione di una bilancia a braccia uguali che fosse stata rimossa dalla situazione orizzontale, se tornasse a questa per se medesima, ovvero rimanesse nella nuova posizione. I prelodati meccanici avevano sostenuto che la bilancia tornerebbe nello stato orizzontale; il Del Monte per altro decise e comprovò, che nel caso delle direzioni parallele, essa rimarrebbe inclinata; ed estese una cotal decisione anche alle direzioni convergenti, quando cioè le forze de' pesi uguali convergano verso il centro della terra. Ivi è certo un errore di non esatta distinzione fra le direzioni medesime; ma perdonato facilmente, sapendosi che in allora mancava la statica conoscenza ai moderni dovuta del centro di gravità, la cui posizione si dimostra fissa nelle direzioni parallele, e varia nel caso delle direzioni convergenti. Tanto è per altro che G. Ubaldo toccò il punto nel primo caso, e seppe con maestrevol'arte confondere ed annientare tutte le in addietro vantate sottigliezze. A confermare poi validamente quanto per sua parte asserisce, egli non si appaga di inconcusse dimostrazioni, ma pone al paraggio quelle degli avversari, e le di loro obbiezioni distrugge con un' analisi ragionata. Tratta in seguito diffusamente della leva, indicandone le proprietà, i vari usi, e i tre modi diversi nel considerarla. Ma qui appunto il suo ingegno fe' mostra dell'innato valore e del profondo accorgimento, come fra poco farommi a dimostrare. Pongasi intanto mente, come della taglia parlando, la riduce alla leva nel lemma primo, e le generali non meno che particolari sue qualità va indicando con un lungo trattato; considera tutti i casi possibili; nota tutte le modificazioni che può ricevere, e tutti gli accidenti che avvengano per le meccaniche forze. Risguarda poscia il cuneo come movente in due modi, cioè in quello della leva, e d'un piano inclinato all'orizzonte; e qui non manca di correggere Giordano Nemorario[1] sopra alcuni falsi supposti che dilucida e rettifica. Passando in seguito alla vite comune, dietro le tracce di Pappo, addimostra altro essa non essere che un cuneo senza percossa, il quale faccia movimento assieme con la leva. Riduce in appresso questa vite alla semplice leva, e fa vedere come agisca in questo senso non meno che in quello d'un piano inclinato. E qui dirovvi che riguardo alla leva gli antichi

[1]Nemorario *correxi ex* Hemorario

avevano poste le loro considerazioni tanto su la diritta che sull'angolare tirata ne'suoi estremi da forze perpendicolari; quindi si passò a contemplare l'equilibrio in un piano, ritenuto da un punto di sospensione e sollecitato da due forze che stiano in ragione inversa delle perpendicolari tirate dal predetto punto sulle loro direzioni. Ora è questa circostanza principalissima di equilibrio che venne dal nostro G. Ubaldo riconosciuta nelle macchine semplici, mediante un attento esame del verricello (26). Tale fama à avea acquistata il Del Monte nelle meccaniche che a lui si volse più volte l'immortale Galileo per a modo di consulta: ed oh come è bello e glorioso per noi il leggere di presente quella lettera che da Padova gli diresse il genio d'Etruria alli 29 novembre 1602 (27) nella quale cercava di convincerlo sulla realtà dei moti fatti in tempi uguali nella medesima quarta di cerchio, e voleva che non venisse ripudiata dalla sua speculazione come quella che fossa falsa, non meritando ella questa nota, né tampoco di essere bandita dall' intelletto di (G. Ubaldo) che più d'ogni altro la poteva più presto ritrarre dall'esiglio delle nostre menti!

Per rispetto poi all'altra celebre vite d'Archimede, egli vi consacra un apposito trattato (de Coclea); ed ivi osserva pel primo, che in quell'istromento havvi un rimarcabile effetto, qual è quello che il peso del corpo e la sua propensione a discendere sono appunto le forze che contribuiscono in qualche modo alla salita. Importante riflesso, e tanto più utile, in quanto[1] che l'errore dei sensi ne facilitava il travisamento, e facilitollo diffatti sino a quel tempo. Questo trattato è una felice unione di geometria pura e di conoscenze meccaniche, perfezionato di poi dal sempre grande Bernoulli nella celebre sua idrodinamica, come nota il più volte lodato Montucla.

La scienza astronomica nata dalla semplice osservazione in principio, e cresciuta per la dotta applicazione di profondi calcoli in appresso, era uscita non a guari dalla mano riformatrice di un Copernico per la parte teorica, e da quella di un Ticone per la prattica. Copernico mise in ordine i corpi celesti, piantò la base della giusta e distinta idea sulla costituzione dell'universo. Ticone divenne maestro universale nell'arte di osservare. Fu allora che la mente sempre grande d'un Gregorio XIII gelosa di adornare il suo pontificato con una riforma quanto strepitosa altrettanto necessaria dei vizi del calendario, impegnò solennemente tutti gli astronomi de' paesi cristiani a proporre le loro idee sui mezzi di rettificarlo. Fu allora che da tutta Europa specialmente accorsero i dotti uomini, solleciti di eternare il loro nome, e alla grand'opera intenti di un sì vero, e generale beneficio. A tale cooperazione si elesse dal duca Francesco Maria II il nostro G. Ubaldo, e in quella occasione per l'appunto scrisse il già indicato libro della correzione dell'anno, ed emendazione del calendario. Questo è un opuscolo di circa 100 pagine, al presente reso non comune, e che egli indirizza al magnifico principe che ne avea prescritto il lavoro: ivi G. Ubaldo espone come fosse suo divisamento. conservare stabilmente l'ecclesiastiche leggi sul tempo della celebrazione della

[1] quanto *correxi ex* qnauto

pasqua, ed ammendare i calcoli astronomici intrapresi per l'avanti a questo fine; tutto però con quella chiarezza e semplicità che può essere intesa dai più. Difatto colla maggiore precisione possibile fissò l'equinozio ai 25 di marzo, mentreché avanti la riforma cadeva agli 11 dello stesso mese; e così portollo all'epoca in cui lo si aveva sul principio dell'era volgare, piuttostoché al giorno vigesimoprimo, come in tempo del concilio niceno; ed è perciò ch'egli propose di togliere dal mese di ottobre quattordici giorni anziché dieci, come si preponeva da altri, e come fu poscia eseguito. E perché da questa emendazione si veniva ad invertere l'ordine del ciclo, egli offerse una tavola, nella quale si vedono determinate quattro serie numeriche, cioè quella dell'aureo numero pei mesi di novembre e dicembre dell'anno da emmendarsi; quella del ciclo dell'anno che immediatamente segue l'ammendato, secondo l'aureo numero esistente nel calendario; quella del ciclo per l'anno emendativo; e in fine l'altra del ciclo per l'anno prossimo, secondo il numero d'ora che fu ai tempi di Cristo. Fissato l'equinozio, passa ad allontanare gli errori futuri e ad evitare il concorso delle circostanze che l'avevano alterato in addietro. Ed affinché in ogni anno l' equinozio cada nel medesimo giorno, propone il bisesto ad ogni quarto secolo[1], che prova bastantemente confare all'uopo, o almeno per lunghissimo spazio di tempo; osservazione, la quale ci convince ognor più dell'esattezza e della precisione da lui ne' calcoli adoperate. Non manca di dare il ciclo per le lettere domenicali nella nuova emendazione, ed una tavola degli anni comuni e bisesti. Ad investigare in seguito le congiunzioni, ed opposizioni astronomiche, egli offre un' altra tavola per trovare il numero d'ora, fissando il 5 per gli anni centenari comuni, ed ottiene così l'opportuna congiunzione per la solennità della pasqua. Determina inoltre come necessariamente si richieda per l'uniformità universale, che il numero d'oro si fissi col meridiano di Roma; esclude il calcolo dell'epatte per la sopraddetta ricerca, abbracciando quello del numero d' oro come più facile e più comune, non ommettendo d' istruirne con chiarezza tutti quelli che mancano d' astronomiche conoscenze.

Per tal guisa il Del Monte si rese benemerito della riformazione de cicli, in Italia concepita e quindi maturata: giacché non ad altro mirava Ignazio Dante allorché eresse in Bologna il celebre gnomone di S. Petronio che ad avvertire sensibilmente e i dotti e gl'indotti di tutta Europa quanta fosse considerevole l'anticipazione dell'equinozio. Così G. Ubaldo apparve nella dottissima schiera degli astronomi più rinomati; così volle essere nominato e riverito fra i migliori che di tale materia si occuparono; e se al Montucla piacque di citare la chiave del Calendario Gregoriano, come uno de' migliori libri apparsi in quell'epoca per opera di Ugolino Martelli, doveva pure analizzare l'opuscolo di G. Ubaldo e quindi recarne giudizio. Che se il progetto del Clavio, o piuttosto quello del Veneziano Lilio fu consecrato dalla pontificia Sanzione, non debbonsi già per questo dimenticare le opere laboriose di coloro che in così ardua intrapresa più s'appressarono alla meta.

Sorse in quei giorni fortunatissimi per l'astronomia il genio sublime di Keplero,

[1]secolo *correxi ex* secocolo

che deve assolutamente chiamarsi il restauratore della vera astronomia fisica. La scoperta delle leggi che seguono i pianeti ne' loro movimenti, alla quale pervenne combinando le proprie con le ticoniane osservazioni, troppo il rendono grande e famoso, perché io qui n' abbia a fare motto veruno. Basta citare la legge della proporzionalità dell'aree ai tempi, e quella dei tempi relativamente ai cubi delle distanze medie, per comprendere in due parole l'elogio di lui più sublime. Un impulso così forte dato alla scienza, ed ai feraci ingegni di quell'epoca, andò privo di effetto per il nostro G. Ubaldo; poiché le leggi di Keplero furono pubblicate nella Astronomia nuova stampata in Praga nel 1609, ed in questo istesso anno si vide alla luce l'astronomico lavoro di G. Ubaldo, che aveva cessato di vivere già da due anni. Due furono le opere in allora stampate, cioè il trattato dei planisferi celesti, e quello dei problemi astronomici diviso in sette libri. Non ragionando del primo, che tuttavia è opera da istimarsi per la prattica descrizione di tutti i circoli massimi della sfera sopra di un piano, per quella delle elissi, e per lo perfezionamento arrecato alle coniche apolloniane, io parlerò del secondo tanto più dotto, quanto più utile, e che con prattici modi c'istruisce della profonda cognizione teorica dell' autore. Né so perché mai di tale studio non parlino gli oltremontani, e i nostri italiani medesimi, eccetto che il Durantini, ed il Riccioli nel suo Almagestum novum. Per quello ch'egli stesso scrive nella prefazione, non ha inteso che di facilitare la via agli studiosi del cielo; e lasciando a Geber, a Tolomeo, a Regiomontano l'investigazione astronomica col mezzo dei seni e dei coseni, alla scienza invita gl'istrutti semplicemente nei primi libri del Megarese, e del Teodosio. Imperciocché nel primo libro diffondesi sulla minima divisione del circolo, sì per le parti dei gradi, e sì per quella delle ore, tanto necessaria agli astronomi, e vari problemi consacra a questa fondamentale operazione. Propone in seguito il modo più facile di osservare per mezzo dei due circoli, orizzontale l'uno e verticale l'altro; trova l'altezza del polo sull'orizzonte per mezzo dell'ombra gnomonica, e di conseguente la distanza dallo senitte, e l'altezza meridiana; l'elevazione del polo sull'orizzonte per mezzo del sole, o di qualunque altra stella, della quale siano conosciuti tutti i dati; e ciò nel modo il più facile. Di fatto quando sono conosciute la longitudine, la latitudine, la declinazione, e l' ascensione retta di un astro, (ma si suppongono ritrovate per mezzo dell'osservazione, come fa l'autore, due altezze non apparenti ma vere, e due azimut veri e corrispondenti di un astro, il quale nell'intervallo delle due osservazioni si sappia non aver mutato almeno sensibilmente la sua declinazione) tale ricerca non monta che ad un problema di astronomia sferica, risoluto da G. Ubaldo assai elegantemente a riga ed a seste. Ivi trova la declinazione di qualsivoglia stella in qualunque ora; quella dei tropici; gli archi semidiurni; e tanti e tanti altri più difficili problemi d'astronomia. Nel secondo, e terzo libro veder possono i dotti contemplatori degli astri assegnata la precisa determinazione della longitudine, e latitudine dei medesimi; la loro declinazione ed ascension retta; la reciproca loro distanza in tutti i diversi casi di conosciuta posizione. Indica nel quarto e quinto il modo di trovare le differenze ascensionali e discensionali in qualsivoglia porzione d'eclitica, e gl'infiniti

problemi eseguibili nella considerazione dello zodiaco. Tratta nel sesto dei crepuscoli, della loro durata e varietà prodotta dalla situazione de' paralleli, e dalla posizione retta od obliqua della sfera. Parla finalmente nel settimo delle comete, ne ricerca la distanza dal mondo, l'altezza sull'orizzonte, il cangiamento apparente, la declinazione, la latitudine, l'ascensione, e la longitudine sì del corpo, e si della coda. Ma sendo a ragionar di comete, sappiate o accademici che G. Ubaldo Del Monte osservò la cometa dell'anno 1604, e scrivendo a Pier Matteo Giordani in data dei 23 novembre, ne precisò la situazione al dieciottesimo grado e mezzo del sagittario, e la sua latitudine di gradi dodici, e quindici secondi. Dove lode grandissima a lui deriva posciacché codeste sue osservazioni furono pienamente confermate per quelle degli astronomi, di Praga; della qual cosa il Del Monte si rallegrava col dotto amico Giordani (28). Pel solo enunciarsi di codesti problemi, è manifesto il giudizio che si debbe recare su' di un opera che elementarmente racchiude tanti tesori astronomici, e che per ordine , chiarezza e diffusione non la cede a verun'altra di que' tempi. Clavio infatti non molto prima d'astronomia scrivendo non fè che otto libri di gnomonica, e commentò gli sferici di Teodosio e l'opera di Sacrobosco. Magino padovano per grande astronomo comendato, non diede che l'effemeridi di molti anni. Giovanni Padovano non iscrisse che sugli errori del calendario, e sull'utilità della sfera. Il Sossiano, il Simo, il Poblacione, e Delfino, e Giacomo Paletario, e Gio. Battista Vimercato suoi contemporanei scrittori di simili materie, o commentarono gli altrui lavori, o parlarono di cosmografia, e di gnomonica, quanto imperfettamente ed oscuri, altrettanto poco originali e fecondi. Di Agostino Ricci non ebbimo che il trattalo Sul moto della sfera ottava dove discute e condanna le idee degli Alfonsini circa al movimento delle fisse di Luca Gamico e di Cardano sappiamo che furono poco più che astrologi; il Maurolico diede un semplice dialogo cosmografico e il Fracastoro più medico che astronomo andò fuori di strada. E posciacché si favella di cose astronomiche ecco che ad encomiare il Del Monte sorge Muzio Oddi suo discepolo, il quale nell'aureo trattato *Degli orologi solari* pubblicato in Venezia nell'anno 1638, a lui decisamente attribuisce la bella invenzione degli orologi solari a raggi refratti. Dissi aureo trattato quello dell'Oddi; e per tale si estima da tutti i matematici che ne livellarono, ivi trovandosi e non altrove i più bei modi prattici ed eleganti di tracciare qualsivoglia orologio piano orizzontale e verticale, non che sopra una data superficie concava o convessa, cilindrica, conica, emisferica, parabolica. In parlando però di quegli altri che sono con tal arte disegnati nella concavità di un vaso sicché mostrano le ore quando il vaso è ripieno d'acqua, alla pagina novantesimanona così chiaramente si esprime: "Ben so de' moderni che l'anno 1572 l'illustrissimo signor Guido Ubaldo de' Marchesi Del Monte ne fece fare uno da Simone Barocci eccellente artefice, in una mezza sfera d'ottone ed hollo avuto nelle mani molto tempo, il quale servì poi come per modello di uno, che d'ordine del Duca Francesco Maria Secondo ne fu fabbricato entro la tazza della fonte che è nel giardino pensile del suo magnifico palazzo d'Urbino" – Per le quali parole dell'inventore di quegli orologi non fessi più luogo a dubitare.

Più grandi elogi si procacciava il Del Monte quando scrisse di prospettiva quell' opera in sei libri divisa, e da noi sul bel principio accennata. Per mezzo della prospettiva si rappresentano su di una superficie piana gli oggetti visibili in quel modo che appariscono ad una data distanza o altezza a traverso d' un piano trasparente, collocato perpendicolarmente all' orizzonte fra l'occhio e l'oggetto. Dividesi essa in ispecolativa, ed in pratica, ed ambedue nell'icnografia e nella scenografia. Figlia primogenita dell'ottica, gl'insegnamenti riceve e le tracce più certe dalla geometria elementare. Sotto questi due aspetti considerata, essa, fra gli scientifici studii è riposta, e in simil guisa trattolla G. Ubaldo Del Monte. Abbiamo in qualche opera degli antichi, e principalmente in quelle di Vitruvio alcuni semi di conoscenze prospettiche; ma i moderni si ponno chiamare a tutta ragione veri inventori di quelle. Ond'è che questa scienza può dirsi ricreata, per opera di Alberto Durero, e Pietro del Borgo che ne han date le prime tracce. Baldassarre Peruzzi le ha migliorate; ma G. Ubaldo fu quello che distesene e semplificò la teoria; sulle sue luminose fatiche tornarono in seguito i Deschales, i Lamy, i Gravesende, i Taylor. In fatti Pomponio Gaurico meritò piuttosto biasimo che lode; Luca Paccioli ne trattò chiaramente ma non alla distesa; la fatica di Pietro Del Borgo andò perduta; e quello che ne diede il Commandino servir dovette di eccitamento piucché di norma al nostro Del Monte. Egli fu grande e forse unico in questa materia: e cel' fanno bastantemente conoscere tutti gli autori che scrissero di lui, i quali per quest'opera principalmente lo esaltano, e lo manifestali grand'uomo. Fin dai tempi di Bernardino Baldi che scriveva in attenzione di questo lavoro dicevasi (29) eh' egli dovesse superare quanti altri avessero scritto intorno quel nobilissimo soggetto; e Tiraboschi, e Andres, e Montucla, hanno poscia ampiamente confermata una tale asserzione. A limitare pertanto il mio discorso, non spiacciavi o accademici di sentire il sopraddetto Montucla, come egli stesso ne ragiona (30) – Tutte le opere suindicate (e sono quelle degli scrittori più accreditati in questa materia) fa d'uopo il confessarlo, non sono molto soddisfacenti per quelli che forniti vanno d'un certo spirito geometrico; egli è perciò che G. Ubaldo più geometra di tutti questi autori citati, riguardò la prospettiva in un modo più dotto di loro. Egli fu il primo che ne vedesse la generalità de' principii. Nel trattato ch'egli diede nel 1600, stabilì questo principio estremamente fecondo, cioè, che tutte le prospettive delle linee parallele fra loro e all' orizzonte sebbene inclinate al piano del quadro, convengono tutte verso un punto della linea orizzontale, e che un tal punto è quello in cui questa linea è incontrata da quella tirata dall' occhio parallelamente alla prima. E qui rilevando la maggiore generalità, a cui doveva estendersi questo principio, dice, che egli per altro soddisfa a tutti i casi ordinarli della prospettiva. Che se condurre si poteva all'infinito la risoluzione del problema indeterminato e fondamentale di tutta la scienza, cioè il determinare l'apparenza d'un qualunque punto dato, G. Ubaldo però fu il primo che ritrovasse la prospettiva di una linea; e ne ricavò quindi le diverse maniere di mettere in prospettiva un punto qualunque: i quali diversi modi sebbene siano per se stessi infiniti , si riducono però tutti ad un medesimo

principio.
Al merito di tali opere fecero plauso i più dotti suoi contemporanei, e i posteri anch'essi in modo veramente singolare e distinto. Viene fra primi il più volte citato Baldi dicendoci (31) Nelle matematiche poi ha genio così grande, e particolarmente nelle cose della geometrìa e delle subalterne, che pare che sia risorta in luì la vivacità dell' ingegno di Archimede – Dove notar si deve che è matematico chi scrive, e che questa è lode fatta all'uomo ancora vivente; ma scarse non sono le lodi in bocca dei contemporanei e dei dotti nelle medesime facoltà, quando si tratta degli eccellenti. Giova a proposito del Baldi l'accertare che sebbene egli scrivesse, come avverte il Monticelli (32), delle vite dei matematici, tuttavia nol fece che sino a quella del P. Clavio[1] Bambergense; e per non lasciar di dire degli altri, stampò la sopraccitata, chiusa col nome di G. Ubaldo Del Monte (33). è dunque evidente che il Baldi non iscrisse vita intera di lui; e l'impressione ancora delle altre, sebbene ivi dal Monticelli annunziata, alla luce non venne, esistono quelle vite manoscritte in Roma nella biblioteca Albani. Il medesimo Monsign. di Guastalla nel libro de' suoi versi e prose stampale in Venezia presso De-Franceschi nel 1590 poeticamente esaltò i meriti del Pesarese (34).
Il Garzoni nella Piazza universale stampata in Venezia nel 1665 (35) dice – Le matematiche più modernamente sono state illustrate dagli scritti di Federico Commandino, e di G. Ubaldo de' marchesi del Monte – Il Gallucci nel panegirico di Pesaro esclama "Ma dove lascio G. Ubaldo del Monte fratello del cardinale Francesco Maria, che ne' scritti suoi singolari si è fatto conoscere l'Archimede e l'Euclide del secol nostro?" E il Galileo nel dialogo quarto de' suoi Discorsi e dimostrazioni matematiche (36), parlando Salviati in risposta al Sagredo così si esprime – ed applicossi l'accademico, Galileo, a questa contemplazione, cioè del centro di gravità dei solidi, ad istanza dell'illustrissimo sig. Marchese G. Ubaldo del Monte grandissimo matematico de' suoi tempi, come le diverse sue opere ne mostrano. E qui solo è da riflettere, che detti sono di un Galileo: ciò che resta poi confermato nella vita di lui premessa all'opere stampate in Padova (37) dove apparisce l'amicizia continua avuta col nostro autore, le obbligazioni che gli manifesta, e l'alta stima che gli professa. Amicizia e stima non minore gli esterna il Tasso colle due lettere a lui scritte di Ferrara, ambo esistenti nelle sue opere (38); e coll'altra manoscritta posseduta dal signor marchese Antaldo Arnaldi di Pesaro; tutte e tre inviategli circa il 1577 e secondo il Serassi (39) tra il gennaio ed il giugno dello stesso anno (40); dove enumerando l'immenso stuolo degli scolari del Commandino, dice – fra questi si annoverò ben tosto anche Torquato; e vi ebbe per condiscepolo il sig. G. Ubaldo de' marchesi del Monte, che poi divenne di quella eccellenza nelle matematiche che il mondo sa. Di quell'eccellenza, riprendo io, che gli meritò il luminoso posto di grande di Spagna e decorollo dell'ordine più glorioso di Francia; a confermare così coi validi voti delle più cospicue regioni d' Europa, la fama acquistata infra i più dotti d'Italia (41).

[1]Clavio *correxi ex* Claudio

Dopo gli encomii de' suoi contemporanei, vengono non minori quelli del Vossio (42), del Poleni (43), del Blancano (44), del Mazzucchelli (45), e del Durantini che ne' suoi tre libri dell'istoria va conchiudendo (46) – Guido Ubaldus e Marchionibus Montis hoc eodem dicendi genere maxime auxit mathematicas disciplinas: scripsit enim praeter sua Planispheria etiam De Maecanicis ac De perspectivis, multo melius ac doctius quam ante eum quisquam alius. His quoque adjunxit problemata et canones coelestes multaque alia, ex quibus operibus comprehendirnus eum illustrissimo scribendi genere etiam familiam suam exornare voluisse. Il Tiraboschi (47) a lui consacra un articolo ben lungo; ed esponendo il numero non che il pregio dell'opere sue, giunge[1] a dire in materia di meccaniche – fu il solo scrittore di quel secolo che ne trattasse in modo da aggiugnere qualche cosa al poco che ne arevano scritto gli antichi – Ed in proposito della prospettiva, ch'egli fu il primo a tentare un nuovo sentiero non mai battuto da alcuno.
Il Santini ne' suoi elogi (48) al capitolo che porta in fronte il nobilissimo titolo Marchionatus de Monte S. Mariae, dice in sulle prime – G. Ubaldus ex marchionibus de Monte inter Friderici Comandini auditores celeberrimus atque de omnibus matheseos partibus optime meritus, plura elucubravit memoratu dignissima. Quindi esponendo la serie de' suoi lavori, e dandone la precisa notizia, conchiude: Ex his omnibus operibus quae profecto ipsi immortalem nominis famam pepererunt, et ex horum quolibet unusquisque facili negocio intelligit, quam profonde penitiores matheseos aditus G. Ubaldus penetravit, quantumque lucis ed araborum tenebras effugandas effuderit. Ma siccome la vera lode che spetta al merito dei dotti si è quella d'un sano ed imparziale giudizio de' loro scritti, dal quale risulti l'importanza degli ultimi, e la celebrità dei primi; così ne viene che l'analisi data de' suoi lavori dal celebre Montucla (49) forma l'elogio più grande che da grande uomo farglisi possa. Tralascio di buon grado il riferire i profondi riflessi che questo storico francese non manca di emettere sul vero pregio di G. Ubaldo, giacché ad ognuno sarà di somma facilità il riscontrarli, ed unire stima e considerazione a perspicacia ed ingegno nel meditarli.
Sebbene dove lascia di favellare Montucla, incominciano due sommi uomini della Francia a commendar G. Ubaldo; e a tale altezza di meriti lo innalzan costoro, che ogni lode sparisce in faccia a quella da lor prodigata. Il celebre De-La-Metherie in un suo discorso preliminare al giornale di fisica, chimica, storia naturale ec. (50) parlando delle meccaniche e particolarmente della nuova opera di Varignon all'articolo delle velocità virtuali attribuisce decisamente questo principio al nostro autore; e lo fa sconosciuto a tutti gli antichi predecessori di G. Ubaldo. Viene in suo appoggio La Grangia e nel tomo primo della nuova edizione della sua Meccanica analitica a pagine 20 così si esprime sul proposito delle velocità virtuali – Passo finalmente al terzo principio, quello delle celerità virtuali. S'intende per celerità virtuale quella che un corpo in equilibrio è disposto a ricevere nel caso che l'equilibrio sia tolto, cioè la celerità che questo corpo realmente acquisterebbe

[1]giunge *correxi ex* giugne

nel primo istante del suo movimento; ed il principio di cui si tratta consiste in ciò che due o più potenze sono in equilibrio quando stanno in ragione inversa delle loro celerità virtuali, calcolate nelle direzioni di queste potenze medesime – Per poco che venghino esaminate le condizioni dell'equilibrio nella leva e nelle altre macchine, facilmente si riconosce questa legge, che i pesi e la potenza sono sempre in ragione inversa degli spazi che gli uni e l'altra ponno percorrere nell'istesso tempo; tuttavia sembra che gli antichi non la conoscessero. Guido Ubaldo è forse il primo che l'abbia rilevata nella leva, e nelle pulegge mobili. Galileo l'ha poscia riconosciuta nei piani inclinati, e nelle macchine che ne dipendono; egli la riguardò come una proprietà generale dell'equilibrio delle macchine (Vedi il suo trattato di Meccanica e lo scolio della seconda proposizione del dialogo terzo nell'edizione bolognese 1655).

Il luogo della scienza meccanica di Galileo, in cui trattasi della velocità virtuale è l'articolo intitolato Alcuni avvertimenti circa le cose dette, il quale viene dopo quello delle Supposizioni al cominciare del trattato. Questo principio è diverso da quello che si chiama Principio della leva e che era noto anche agli antichi. La Grangia parlando di quest'ultimo al n. 1 dice "Archimede ... . è l'autore del principio della leva il quale, come tutti i meccanici sanno, consiste in questo che se una leva diritta è caricata da due pesi qualsiano posti al di qua e al di là del punto d'appoggio in distanze reciprocamente pro" porzionali ai pesi suddetti, la leva sarà in equilibrio, ed il suo ipomoclio sarà caricato della somma dei due pesi." – Fatta questa distinzione fra i due principii delle velocità virtuali, e della leva, quale sarà nel libro della leva di G. Ubaldo quella proposizione che racchiuda il principio delle velocità virtuali? Ve ne saranno molte. A me pare però che si trovi chiaramente espressa nella dimostrazione del corollario della proposizione IV, con quelle parole – Spalium enim potentiae ad spatium ponderis eandem habet proportionem quam pondus ad potentiam pondus substinentem – giacché con queste parole viene con tutta verità enunciato che nella leva la ragione del peso alla potenza è inversa di quella degli spazi che percorrerebbero nel medesimo tempo, allorché fosse rotto l'equilibrio, e perciò inversa di quella delle velocità che sono disposti a ricevere nel caso che l'equilibrio venga ad esser tolto, ossia delle velocità che questi corpi realmente prenderebbero nel primo istante del loro moto. Ciò posto e comprovatosi da noi essere G. Ubaldo primo scuopritore di tale principio, chi non ravvisa la sublimità, la fecondità, e l'importanza di una tale scoperta? Chi potrà in un so1 punto raccogliere, e in pochi termini esprimere l'estesissime applicazioni che di questo principio si fecero, e il vasto campo che aperse ai meccanici scrittori? Basta il riflettere che tutti problemi delle forze vive di Leibnizio, e quelli delle forze morte del medesimo non formerebbero ora una delle più grandi proprietà dei corpi conosciuti, ed uno de' calcoli più necessari in meccanica, se non precedeva la scoperta delle velocità virtuali. Imperocché senza pere che la forza morta è come il prodotto della massa per la celerità virtuale, questa forza m sarebbe stata calcolata, come non lo fu da principio; e perciò saria pur seguitato l'antico errore della non attesa distinzione fra le forze vive

e le morte, e per necessaria conseguenza sommo equivoco di calcolo nel movimento o nel riposo di tutti i corpi naturali. Né altrimenti conchiuse il La Grangia quando asserì, che tutti i principii generali che si potessero ancora scuoprire nella statica, si dovranno sempre riferire a quello delle celerità virtuali, o non sanno a dir meglio che quel medesimo in diversa guisa considerato, e sotto diverse forme accennato. Anzi il Montucla precisamente conchiude, nella formola delle velocità virtuali stanno riposti tutti i teoremi conosciuti sotto i nomi conservazione delle forze vive, del momento del centro gravifico, del momento di attrazione, e del principio della minor quantità, i quali sono generali risultamenti delle leggi dinamiche (51). Chiaro adunque risulta l'intima connessione che il grandioso principio di Leibnizio ha per natura con quello delle celerità virtuali, e che perciò non poteva egli idearsi prima della conoscenza di queste ultime. Basta il considerare che Galileo medesimo, l'immortal Galileo, è dovuto tornare su questo principio, riconoscerlo, e risguardarlo come una proprietà generale dell'equilibrio delle macchine; e qui farò di volo osservare la nobile emulazione di questi due ingegni italiani, i quali indefessamente rivolti all'aumento della scienza, ambedue si arrestano ad estenderne la teoria sovra un punto medesimo; e compagni nello studio delle matematiche, G. Ubaldo per età non meno che per fatiche più vecchio del Galileo, a lui insegna la via, e somministra i mezzi a percorrerla; a lui che in Italia, e nel mondo prodigio comparve del più raro sapere. Basta in fine il por mente che Giovanni Bernoulli, primo conoscitore della generalità, a cui si estendano le celerità virtuali, e l infinita utilità loro per risolvere i problemi di statica, avrà dovuto ricorrere a G. Ubaldo per ricevere da lui la fondamentale proposizione succennata, onde ridurla al sistema generalissimo de' piccoli corpi spinti o tirati da potenze citai siano facentisi equilibrio; locchè non è che una estesa applicazione dell'anzidetta scoperta, dalla quale finalmente Varignon trasse la giustissima idea di applicarla all'equilibrio di tutte le macchine semplici. Né già è da supporsi ch'io trasportato dall'amore d'encomio voglia esagerare i meriti di G. Ubaldo per un simile trovato; conseguenze son queste dal fatto stesso derivanti, e dir non puossi che dall'anzidetto principio non traessero poi lutti gli altri le loro utili applicazioni, come non si può asserire che dal principio d' Archimede sull'equilibrio de' corpi, tutti i posteri scienziati, e il nostro G. Ubaldo medesimo le meccaniche loro fatiche non ricavassero.

Ma non è tutto. G. Ubaldo del Monte sembra aver introdotto nella statica anche il principio de' momenti; giacché La Grangia al num. 4 dice – "Una forza può risguardarsi come applicata a qualsivoglia punto della sua direzione. Dunque due forze applicate a de' punti qualsiano d'un piano attaccato stabilmente, e dirette comunque su questo piano, tirate sono in equilibrio quando stanno fra loro in ragione inversa delle perpendicolari abbassate da questo punto sulle loro direzioni; mentre ponno queste perpendicolari essere considerate come braccia d'una leva angolare il cui punto d'appoggio è il punto fisso del piano: questo è quello che ora dicesi principio dei momenti, intendendosi per momento il prodotto di una forza per le braccia della leva su la quale ella agisce. Il principio generale basta

a risolvere i problemi di statica, e lo studio fatto sul verricello il mostrò già nei primi passi fatti dopo Archimede nella teoria delle macchine semplici, come chiaramente si vede per l'opera di G. Ubaldo intitolala Mec<h>anicorum Liber che comparve in Pesaro nel 1577." -
Dopo tutto ciò è chiaro che G. Ubaldo del Monte fu giustamente reputato uno dei celebri matematici del suo secolo; e in punto poi di meccanica e di prospettiva sia da riporsi fra i sommi autori della nazione. Onde è che per lui come per tanti altri suoi figli a somma onoranza si leva questa nostra patria; la quale, o accademici, noi dobbiamo con ogni sforzo difendere dal più crudele nemico, l'obblio della gloria trascorsa.

NOTE

(1) Nella Cronaca de' Matematici anno 1596 Ediz. Urbin. del 1707 pel Monticelli.
(2) Lettere. Lib.I. Venezia 1582 (nella dedicatoria dei 22 marzo 1561 scritta a Raniero del Monte).
(3) Vedi 1'Almerici negli Spogli esistenti presso la Bibl. Oliveriana: squarcio C.B. carte 2, 8.
(4) Idem.
(5) Hist. des mathèm. T. I pag. 690 Edit. Paris. Anno VII, e precisamente alla pag. 709.
(6) Storia ec. T. VII parte I Lib. II cap. a 38.
(7) Ecco la lapide sepolcrale esistente ne' manoscritti dell' Oliveriana

D O. M.
GVIDO . VBALDO E . MARCHIONIBVS
MONTIS . S. MARIAE
MONTIS . BIROTII . COMITI . SECVNDO
ARTIBVS . EGREGIIS . SCIENTIISQVE
PRAESERTIM . MATHEMATICIS
EMINENTISSIMO . CVIVS
PRECLARAS.VIRTVTES
MODESTIA . ORNAVIT
QUI . SANCTISSIME . OBIIT
EXEVNTE . AETATIS . SVAE
ANNO . LXII . SALVTIS . VERO
M.D.C.VII . VII . ID. IAN.
FELIX . DE . RVVERE . ET . FILII
CONIVGI . ET . PATRI
OPTIME . MERITO

(8) Saggio sulla storia generale delle matematiche. Ediz. prima Ital. con agg. di G. Fontana, Milano 1802 T. II pag. ultima.

(9) Santini. Elogii de'Matem. del Piceno. Ediz. Macer. 1779.
(10) Serassi. Vita del Tasso pag. 90.
(11) Loco citato.
(12) Loco citato.
(13) Mechanicorum liber dicatus ab auctore G. Ubal. Francisco Mariae II urbinatum amplissimo duci. Pisauri apud Concord. 1577 (in fogl.)
(14) G. Ubaldi e Marchionibus Montis Planispheriorum universalium Theori<c>a. Pisauri apud Concord. 1579 (in 4.)
(15) De Ecclesiastici Kalendarii restitutione. Pisauri 1580.
(16) In duos Archimedis equiponderantium libros Paraphrasis Pisauri apud Concord. 1588 (in 4.)
(17) Perspectivae lib. VI Pisauri apud Concord. 1600 (in f.)
(18) Problematum Astronomicorum lib. VII. Venetiis apud Bemardinum Juntam et Jo. Bapt. Ciottum 1609 (in fol.)
(19) De Cochlea Lib. IV. Venetiis apud Evang. Deuchinum, 1615.
(20) Essai sur les ouvrages phisico-mathematiques de Leonard de Vinci. Paris An. V. 1797.
(21) Vedine 1'introduz. alla pagina prima.
(22) Pagina prima.
(23) Pagina decimaterza.
(24) Pagina decimaquinta.
(25) Pagina ultima.
(26) Franchini. Supp. alla Storia Matem. 1824, pag. 61.
(27) Opere del Galileo. Ediz. Fior. 1718. T. 3 pag. 716.
(28) Vedi le lettere dell'autore conservate nell'Oliveriana nel codice 426 L. 187 e 189.
(29) Loc. cit
(30) Pag. 709. (loc. cit.) sur la Pérspective.
(31) Loc. cit. anno 1596 pag. 155.
(32) Pref. dello stamp. alla Croniea sud. pag. 4.
(33) Idem.
(34) Egloga XVI.
... Ivi è l'eroe del Monte
Nato di regia stirpe in cui riluce
Quanta bontà, quanto valore, e quanto
Può donar senno ad uom mortale il cielo,
Questi acuto mirando, ed a le carte
Confidando vivaci i bei pensieri ,
Stupir fa il mondo, e in guisa tal disvela
De' corpi eterni in un le forme e i moti,
Che quel ehe sembra altrui troppo alto e scuro,
Fa chiaro, e piano...
(35) Pag. 561.

(36) Ediz. bologn. 1555 pag. 218.
(37) Anno 1744 pag. 511.
(38) Edit. Venet. 1738 alla pagina 304 e 306.
(39) Vita del Tasso. Bergamo 1700 pag. a 275.
(40) (Loe cit. pag. 98).
(41) Ciò risulta da lettere originali trovate nell' archivio detta famiglia del Monte dal sig. Teofilo Betti pesarese.
(42) De natura artium. Lib. III c. 500.
(43) Exercit. vitruv. I pag. 99.
(44) Vita d'Archim. pag. 111.
(45) Lib. II cap. 14 pag. 73.
(46) Chronol. Mathem. pag. 62.
(47) Storia cit. T. VII par. I lib. II cap. 11 p. 38.
(48) Ric. mathemat. elogia. Macerat. 1779.
(49) Ai luoghi citati.
(50) An. 1821. Février. pag. 58.
(51) Part. V. lib. 3 pag. 611.

II.4 Bonamini's *Vita* of Guidobaldo

An informative biography of Guidobaldo is contained in the work "Abecedario degli architetti pesaresi" of Domenico Bonamini (1760-1790ca.), conserved at BOP, ms 1009.[1]
This *Vita* of Guidobaldo, comprising the pages 59-61, shows clear traces of the consultation of BOP ms 758 (cf. Appendix I, II.2):

> 1580 Del Monte Marchese Guidubaldo
> Il tempo in cui fiorì in Pesaro il Marchese Guidubaldo del Monte, figlio primogenito del menzionato Raniero, può a ragione chiamarsi l'epoca del ristabilimento dell'architettura accaduto nel nostro paese. Troppo eccellente era stato il di lui maestro Signor Federico Comandino d'Urbino onde, aggiunti tanti studi di matematica, di prospettiva, fatti e dati alla luce coi suoi noti libri dal nostro Marchese dal Monte, non dovesse succedere il divisato cambiamento.
> Né bastarono a Guidubaldo l'aver dati tanti precetti coi libri, ché pensò ancora di darli coll'esempio e colla viva voce erudendo varie persone allorché, ammalato di sciatica nel più bel fiore di sua gioventù, convennegli per tanto tempo stare inchiodato in un letto. Può conoscersi dal principio dell'opera *Prospectivae libri sex*, Pisauri per Hieronimum Concordiam 1600 in folio, quanta stima facesse il Mar-

[1]The manuscript is transcribed and published in D. Bonamini, *Abecedario degli architetti e pittori pesaresi*, ed. by G. Patrignani, in "Pesaro città e contà, VI (1996).

chese della scienza dell'architettura che, se non è regolata dai sodi e veri principi della prospettiva, sempre sarà diffettosa, come l'abbiamo veduta per tanti e tanti secoli barbarici essere il disonore degl'italiani, e quindi il loro più bell'ornamento.

E per toccare qualche cosa delle memorie di questo eccellente nostro concittadino, sappiasi che i citato Giovan Francesco Lancellotti, avendo vedute tutte le carte appartenenti a tale famiglia colla maggiore precisione, ha lasciato scritto che Guidubaldo naque li 11 gennaio 1545 il dì di domenica all'ore dodici e mezza; che da ragazzo visse sotto la disciplina de' medesimi maestri del principe Francesco Maria II della Rovere; di grammatica messer Lodovico Corrado, di musica Paolo Animuccia e Fra' Costanzo Porta minore osservante. In età d'anni 19 andò a Padova e si trattenne un anno. Ritornò, studiò sotto il Commandino e conversò coi più rari professori delle scienze mattematiche, tra quali furono Monsignor Vescovo di Pesaro (cioè Monsignor Cesare Benedetti), il Signor Federco Bonaventura (urbinate), il Signor Mazzoni (di Cesena), il Signor Abate di Guastalla (cioè il Conte Giovan Battista Mamiani)[1], il Signor Galileo Galilei ed il Signor Pier Matteo Giordani già menzionato.

D'anni 22 andò alle guerre d'Ungheria con carica di 3000 fanti. Poi col nostro Duca Francesco Maria II passò in Messina ed ivi s'amalò di sciatica avendo allora anni 30. Tornò in patria, poi si portò a Padova per liberarsi da tal male, che lo perseguitò fino agli estremi della vita. Nell'anno 1588 ebbe commissione dal Gran Duca di Toscana che gli aveva fatto far cardinale il // fratello Francesco Maria del Monte, di visitare tutte le fortezze dello stato e questa fu la cagione della fierissima gelosia colla quale lo vide poi Francesco Maria II suo signore, scacciandolo dalla corte assieme col primogenito di Guidubaldo. Dell'anno 1606 di marzo s'infermò di debolezza di stomaco e s'avanzò talmente il male che, dopo sei mesi di malatia, ai 6 di gennaio 1607, finì di vivere e fu sepolto nella chilsa delle nostre monache del Corpus Domini colla seguente inscrizione, ch'or più non si vede:

Guido Ubaldo e marchionibus
Sanctae Mariae, Montis Birotii
Comiti II, artibus egregiis scientiisque
praesertim mathematicis eminentissimo
cuius praeclaras virtutes modestia ornavit
religio superavit,
qui sanctissime obiit exeunte aetatis anno LXII
salutis vero MDCVII, VIII idus ianuarii:

[1]Bonamini, or his source, makes a mistake here: it obviously is Bernardino Baldi who is referred to with "abbot of Guastalla".

Felix de Ruvere et filii
coniugi et patri optime merito.

Felice della Rovere, figlia naturale del duca Guidubaldo e della Signora Catterina Pistori di Firenze, fu la moglie del Marchese Guidubaldo, che gli generò dicesette figli. Troppo lungo io sarei s'ora dell'immense opere date alle stampe del Marchese del Monte io volessi far parola. Basti qui ora annotare ciò che può essere relativo alla scienza architettonica da lui a maraviglia posseduta.

II.5 The entry on Guidobaldo in P. Litta

Another interesting biography of Guidobaldo is contained in P. Litta, *Famiglie celebri italiane*, 16 vols., Torino, Basadonna, 1819-1864. The respective entry reads:

GUIDUBALDO
Nato in Pesaro nel 1545, 11 gennaio. Studiò dapprima in Padova, poi presso il Commandino in Urbino, ove contrasse amicizia col Tasso, che gli era collega agli studi. Diventò soldato, e nel 1571 seguì Francesco Mari adella Rovere alla guerra contro i turchi, ma obbligato da gravi infermità a fermarsi in Messina, non ebbe la consolazione di assistere ad un fatto di guerra. Ritornato a casa, la sua mente non fu più occupata che delle scienze esatte, e in breve tempo fu da tutta l'Europa venerato quale matematico d'altissimo grido.
Cominciò nel 1577 a pubblicare in Pesaro l'opera *Mechanicorum Liber*, la quale tradotta da Filippo Pigafetta[1] ricomparve in Venezia nel 1615, opera che fu sommamente aggradita, mentre da Archimede in poi non era mai comparsa ancora opera di pregio in quel ramo di matematiche. Due anni dopo nel 1579 pubblicò il suo *Planispheriorum Universalium Theorica*[2]. Nel 1581 fu uno de' matematici interrogati da Gregorio XIII sulla correzione del Calendario, problema che doveva sciogliersi col conservare però stabilmente il tempo prescritto da' canoni della celebrazione della Pasqua. In tale occasione Guidubaldo scrisse *De Eclesiastici Kalendarii restitutione opusculum.* Fu adottato nel 1583 il metodo di Luigi Lilio, ma è vero che anche quello proposto da Guidubaldo consisteva nella soppressione di vari giorni di ottobre. Dopo aver fatto nel 1585 molti viaggi per l'Europa, nel 1588 fu chiamato in Toscana qual visitatore di tutte le città e fortezze di

[1] Pigafetta *correxi ex* Pigaletta
[2] Theorica *correxi ex* Theoria

quello stato. In quell'anno aveva pubblicato l'opera sul centro di gravità dei piani col titolo *In duos Archimedis Equeponderantium libros Paraphrasis*. Pubblicò altresì nel medesimo anno le opere commentate di *Pappo Alessandrino*, della quali il Commandino[1] si era assunto l'incarico, e che prevenuto dalla morte non aveva portato a fine. Nel 1589 fu chiamato a Firenze per intervenire alla nozze del Granduca Ferdinando con Cristina di Lorena. Nel 1592 fu confaloniere di Pesaro. Nel 1598 quando Clemente VIII provenendo da Roma per recarsi a prendere possesso di Ferrara, passò per Pesaro, siccome era uso allora, che si levassero le porte delle città e che si mettessero a terra, acciò sopra vi passasse in segno di sovranità la cavalcata pontificia, Guidubaldo in questa occasione inventò una macchina, mediante la quale al comparire del corteggio pontificio le pesanti porte uscirono da' gangheri e in un batter d'occhio si disposero sul terreno.
Nel 1600 ci diè un altro lavoro col titolo *Prospectivae libri VI* ove trattò di quella parte di essa da' greci chiamata *Scenografia*, e fu il primo a trattare questo argomento, e questo fu l'ultimo suo lavoro in vita.
Nel 1602 il Duca d'Urbino volle ritirarsi a Casteldurante, nella quale occasione non permise per gelosia che rimanessero in Pesaro alcuni de' suoi congiunti, e anche Guidubaldo che gli era cognato, ebbe l'ordine di recarsi al feudo di Monte Baroccio. Tollerò il fatto spiacevole, e la sua solitudine fu mitigata dallae sue occupazioni, ma dopo tre anni gli fu poi conceduto di ritornare alla città, ove morì nel 1607, 7 gennaio, e fu sepolto presso le monache di S.a Chiara di Pesaro, le quali, non so per qual capriccio, dispersero le sue ceneri, non rimanendovi di sì illustre uomo che la copia dell'iscrizione mortuaria conservata nell'Oliveriana di Pesaro.
Due sue opere rimaste inedite pubblicò in Venezia il figlio suo Orazio l'una nell'anno 1609 chiamata *Problematum Astronomicorum libri septem* e l'altra *De Coclea libri IV* che Orazio trovando incompleta portò a termine. Due manoscritti che gli appartengono si sono poi trovati nella biblioteca Oliveriana di Pesaro, l'uno intorno al quinto libro d'Euclide, l'altro il trattato sulla proporzione composta. La Meccanica e la Prospettiva furono gli studi suoi prediletti, ed ha il merito d'avere dato i principi fondamentali di que' due rami della scienza. Il Tasso fece per lui il sonetto *Misurator de' gran celesti campi*. Alcuni vogliono, che fosse fatto grande di Spagna e cavaliere degli Ordini del Re di Francia. Non vale l'occuparsi alla verificazione, mentre se le sue glorie si limitassero a questi onori, nessuno certamente lo conoscerebbe.

[1] Commandino *correxi ex* Commendino

Part E

Appendix II: Documents for a reconstruction of Guidobaldo's ambiance

Chapter I

Sources concerning the socio-political situation of the Duchy of Urbino and the position of the dal Monte family in it

Appendix II presents documents that are relevant for the reconstruction of the milieu in which Guidobaldo's grew up: the first section of chapter I exposes sources that regard the political and socio-economical situation of the Duchy of Urbino in the second half of the sixteenth century: an important documentation in this regard is given by the reports of the Venetian ambassadors (section I.1). The following sections present information about important characters of the dal Monte family, particularly about Ranieri and Cardinal Francesco Maria dal Monte: the cognition of certain details of their lifes seems to be important also for a better understanding for the biography of Guidobaldo himself.
Chapter II is dedicated to the biographies and sources relative of/to Guidobaldo's most important interlocutors and collaborators.

The criteria followed in transcribing the sources in the present appendix are the same as the one exposed at the beginning of Appendix I.

I.1 The "Relazioni al Senato Veneto"

Interesting descriptions of the Duchy of Urbino are constituted by the relations that the Venetian ambassadors sent to their senate in various occasions:[1] the first one was the death of Duke Guidobaldo II's first wife Giulia Varano in 1547 with Federico Badoer as ambassador. Then, in 1571 Lazaro Mocenigo represented the

[1] These relations are published in A. Segarizzi (edit.), *Relazioni degli Ambasciatori veneti al Senato*, 4 voll., vol II, Bari, Laterza, 1913.

Venetian republic at Prince Francesco Maria's marriage with Lucrezia d'Este. Only four years later, some months after the death of Guidobaldo II, Matteo Zane was sent to the Duchy to make his embassy with the new Duke.
The *Relazioni al Senato Veneto* furnish us interesting snapshots of the Duchy of Urbino, with information about the economy, the court, the population, the military situation and many other things.

Badoer's relation of 1547

We cite Badoer's relation only partly. The page references in square brackets relate to the page numbers of Segarizzi's edition.[1]

> "Relazione di Federico Badoer, Ambasciatore a Guidobaldo II della Rovere, Duca di Urbino, 1547"
>
> [p.159 (beginning)] Quando per grazia della Serenità Vostra e delle Signorie Vostre ecellentissime, serenissimo Prencipe, illustrissimi e sapientissimi Signori, io fui eletto ambasciatore al Signor Duca di Urbino, dirò liberamente quel ch'è vero, mi parve ben di restar grandemente obligato a questo eccellentissimo Senato; ma non però credevo che mi fosse commesso negozio di molta importanza, si percioché la cagione per la quale io era mandato non avea bisogno di molta opera, sì percioché mi pareva che, non essendo quello Stato molto grande, non potessi io ritrovar molte cose in esso degne di esser narrate e ponderate in questo eccellentissimo Senato. Ma invero io ritruovo essermi di questo mio pensiero ingannato; ché, essendo stato appresso quel Signore ed avendo molto ben posto mente a tutto quello che io ho giudicato che si convenga considerare, mi son risoluto esser pochi Stati in Italia che possano venir in maggior considerazione con questa eccellentissima republica di quanto può quello di Urbino. E perciò ho deliberato di narrare e ponderare fedelmente tutte quelle cose che mi son parute degne della intelligenza di questo illustrissimo Senato. (...)
>
> [p.161:] A' ventiquattro, la mattina, il Signor don Giulio <della Rovere> venne a trovarmi, ed andammo insieme a levar il Signor Duca per andar alle essequie <i funerali della Duchessa Giulia Varano>, le quali furono celebrate con assai gran pompa, e vi si ritrovarono diversi ambasciatori de' principi: Ferrara, Piacenza, Mantova, Milano, Fiorenza ed altri. Accompagnai Sua Eccellenza alle essequie, alle quali si ritrovavano quelli ambasciatori di prencipi, agenti di cardinali e di cittá diverse, che furono in numero 235, come scrissi particolarmente

[1] Segarizzi writes in the apparatus in regard of Badoer's relation: "Per la morte di Giulia di Giovanni Maria Varano, moglie di Guidobaldo II Della Rovere, Duca d'Urbino, il senato inviò come ambasciatore straordinario Federico Badoer (...) L'ambasceria del Badoer durò quattro giorni (...)"

alla Serenità Vostra. L'essequie furono fatte con assai gran pompa: nell'apparato e cere nel duomo furono spesi 4000 ducati; in altre spese, come dapoi ho intesi, cioè in alloggiar tutti gli ambasciatori d'ogni Stato, con le cavalcature, che erano più di 500 persone, ha speso Sua Eccellenza 6000 ducati: che in tutto fa 10.000, spesa molto grande alle sue forze. L'eccellente dottore messer Speron Speroni, come scrissi alla Serentià Vostra, fece l'orazione funebre, la qual fu laudata da tutti supremamente e, mentre ch'egli parlava, il Duca lagrimò assai, e così la maggior parte dei astanti.

[p.163:] Il Signor Duca è d'età di 33 anni. La forma del suo corpo è quadrata, come sanno la Serenità Vostra e le Signorie Vostre eccellentissime, che più volte l'han veduto; di stature è // manco che mediocre; di complessione melanconica mista col sangue; sano della persona, ed assai forte e destro, per quello che s'è potuto vedere per il passato negli essercizi corporali, e spezialmente alla giostra di Ferrara, che fu già 13 anni (salvo il vero), nella quale si disse ch'egli fece maggiore prova d'ogni altro he vi si trovasse allora. I suoi essercizi sono questi: la mattina primieramente ode la messa, va poi alla stalla de' cavalli, camina, desina, ragiona, va all'armeria, poi al giuoco della palla con l'archetto, cavalca e poi negozia, e la sera, innanzi cena, legge. È tenuto persona religiosa, per quello che si vede nelle cose estrinseche; molto giusto, per quello che la Serenità Vostra e le Sgnorie Vostre eccellentissime intenderanno, quando parlerò della sua corte. Egli è stimato prudente, percioché pensa molto sopra le cose ch'egli ha da fare o dire, e vuole consiglio di coloro che gli paiono bastanti a darglielo; e, fatta la risoluzione di quello che egli ha pensato di fare, egli vuole che vi sia data essecuzione per ogni modo, a quel tempo ed a quell'ora medesima, ch'egli averà dissegnato, e, quando egli vede che non sia a punto essequito secondo il suo disegno, egli s'altera grandemente. Negli affetti dell'animo, per quello ho inteso da molti, egli sente più il dolore nelle cose averse che l'allegrezza nelle prospere. Egli dimostra d'essere desiderosissimo d'onore, e l'ho sentito più volte laudar sommamente coloro che gli pare che abbian detto ed operato qualche cose egregia, e biasimare con gran parole molti capitani, e antichi e moderni, che per qualche suo utile particolare han fatto cosa non degna di capitani. Ha usato Sua Eccellenza liberalità nel rimunerare servitori benemeriti del padre e suoi, donando possessioni ed alcuni castelli, come sarebbe a dire al Signor Ranieri dal Monte, al Conte Irazio Florido, al Conte Giovanni Giacomo Leonardo (...)

[p.165] La corte del Duca e di tutta quella casa, come per una consuetudine, è stata sempre onorevole, percioché in ogni tempo, e nell'armi e nelle lettere, ella ha avuto de' più segnalati uomini d'Italia. Usa questo Duca di torre quasi tutti de' suoi sudditi quelli de'

quali egli disegna servirsi in ogni maneggio. E questo egli lo fa, percioché gli par essere come certo della lor fede ed amorevolezza verso le cose sue, e, facendo questo, egli viene a dar animo a' suoi sudditi di caminare per la strada della virtù. E così i sudditi attendono a diversi essercizi, per poter accrescere le sue condizioni appresso Sua Eccellenza, la quale per questo è ben servita in ogni officio.
Intorno alla giustizia mi pare, per quello che ho potuto comprendere, che assai prudentemente si proceda; percioché prima // in ogni città vi sono i suoi magistrati, in alcuna luogotenente e podestà, ed in alcuna podestà solo, in alcuna commissari, in altra vi tiene capitani, ed alcuna egli ha dato il governo de' vicari. I podestà sono i primi conoscitori delle cause nella prima instanzia; i luogotenenti, oltra il governo dello Stato, sono giudici delle appellazioni. E, perché in molte parti dello Stato alla terminazion di qualche causa si ricercavano tre sentenzie conformi, secondo l'ordinaria disposizion delle leggi, ha giudicato questo presente Duca esser molto commodo de' suoi vassalli ordinar generalmente che da due sentenzie conformi non sia lecito appellare: decreto ricevuto con infinito contento da tutto lo Stato. Quando in Pesaro, Ugubio o Senigaglia non concordino i primi giudici, il Prencipe dà un giudice secondo, che le qualità della causa, delle persone o del luogo ricercano. (...)

[p.166] Le cause criminali sono giudicate co' propri statuti ed ordini de' luoghi, come le civili. Solamente il Duca, quando gli perviene a notizia qualche cosa che sia occorsa, scrive ammonendo podestà e luogotenenti che facciano giustizia secondo la disposizione delle leggi. Questo signore ha fatto alcuni decreti generali per punire certi errori più enormi, nei quali ha imposto pena della vita o altre minori personali per terrore degli insolenti, come nelle violenzie che si facessero a donne, in resistenza con armi // che si facesse agli essecutori della giustizia, in vendette contra persone congionte a coloro da' quali fossero stati offesi e fuor della propria persona dell'offendente, falsità o altri simili gravissimi eccessi.
Oltra tutti gli altri giudici, vi sono dui auditori o consiglieri. Questi hanno curo di provedere che si faccia giustizia da tutti gli altri giudici, e rappresentano la persona del Duca; ché, avendo avuto in costume quella famiglia di dar opera al mestier d'armi, ha introdotto i creare questi auditori, i quali in suo luogo attendono alle cose della giustizia. Quelli che ricorrono ai predetti auditori (che sono ogni giorno molti) non dimorano mai più tempo per conseguir la espedizion delle domande loro che mezo giorno, perché, raccogliendosi insieme mattina e sera, si spedisce ciascuno avanti che essi eschino d'audienzia. Sua Eccellenza commette ancora a questi auditori qualche causa particolare che gli paresse, per convenienti rispetti, troncar speditamente, né

lasciarla al giudicio degli ordinari.(...)

[p. 171] Vi è poi de' conti ed altri signori temporali, in numero 18, parte de' quali pagano feudo al Duca: quasi tutti hanno per principal professione la milizia. Vi è il Signor Aurelio Fregoso, il quale ha in feudo dal Duca 13 castelli; i conti da Montevecchio, un de' quali è il Conte Giulio, che serve la Serenità Vostra, persona di gran fede e molto prudente, come sanno le Signorie Vostre eccellentissime, il quale è grandemente amato ed istimato non solo dal Signor Duca, ma da tutti quei capitani gentiluomini ed altri soldati; il Conte Prospero suo fratello, il Conte Roberto, il Conte Ridolfo suoi cugini, pur di Montevecchio, nati e creati alla guerra; il conte Girolamo, il Conte Gianfrancesco, il Conte Brancaleone da Dragnano; il Conte Carlo, cugino di questi, e gli altri di Pian di Meleto; il conte di Sascorbara; il Conte della Meldula; quei signori Malatesti da Sogliano e quei da Rimini; i Signori da Montaguto; il Conte Orazio e fratelli di Carpegna; i Conti della Gattaia, che sono molti; il Conte Gianfrancesco e gli altri Conti da Bagno; il Signor Montino, il Signor Ranieri, il Signor Cerbone, il Signor Pietro ed altri Signori dal Monte; il Conte Antonio dalla Genga e suoi fratelli; il Signor di Monte Marciano. Sono in confini ancora i Signori // Vitelli e quelli conti di Montebello, il Signor Aurelio Fregoso ed altri molti di quei Signori, i quali non mi ricordo che sono in confino; e tutti vivono alla guerra. (...)

[p.174] L'entrata che trae il Duca dal suo Stato non è più di 40000 ducati e manco, per quello che ho inteso per buona via, benché tutti dicono 45000. L'entrata è molto piccola, avendi rispetto allo Stato che ha Sua Eccellenza, la quale fa questa publica professione di non voler gravare di niente i suoi sudditi. E credo, per openion mia, che ad un certo modo egli abbia necessità di farlo, considerando molte cose. Pesaro, ch'è terra piú mercantesca delle altre, non paga di dazio di mercantanzia piú di 400 ducati. Ha messo Sua Eccellenza una sola tassa a tutto lo Stato di 4000 ducati, i quali son dedicati alla fortificazioni delle città, ed a questa tutti contribuiscono volentieri. La spesa poi è assai, non voglio dir grande, percioché l'entrata nol comporta, ma assai maggiore di quello che comporta la sua entrata; di modo che, se 'l presente Duca ed i suoi passati non avesser avuto lo stipendio dalla Serenità Vostra e da altri prencipi, eglino non averebbon potuto, né potrebbe il Duca presente, portar il peso di spese così grandi. Il Duca, nel prendere il grado di governator generale, ha speso straordinariamente 15000 scudi. E tutte queste spese son fatte da Sua Eccellenza, oltra i pagamente de' salari de' magistrati e altri officiali delle sue città, in dar trattenimento a quei capitani che non può intertener col modo ch'egli ha da questo Stato. Fra i quali si ritrovan al governo della fanteria il conte Orazio, il colonello Antenore,

il capitano Pasqualino Albanese, che sono uomini segnalati, per fanti quanto siano in Italia, per condurre un grosso e bon colonello.
Si ritrova da 50 capitani, tra' quali se ne veggono da forte 28 nel rollo dei leggeri, che Sua Eccellenza intertiene con molta sua spesa. Nelle gendarme vi sono il capitano Ricciardo Cropello, il capitano Sebastiano da Fermo, il cavalier Ferrarese, il Capitano Cotton e diversi altri, atti a governare una grossa e buona banda di gente d'arme. Ha anco Sua Eccellenza il Conte Chimente, il Signor Biordo da Ortona, messer Sebastiano Bonaventura, Giannantonio da Cesena ed altri diversi, che tutti hanno avuto carico alla guerra di gendarme molto onoratamente. Ne' cavalli leggeri il Capitano Prette, il Capitano // Agnello, il Capitano Cesare, il Capitano Alessandro dalla Carda e molti altri che sono stati e sono di gran credito nel governo de' cavalli leggeri. Al servizio di Sua Eccellenza sono il Signor Ranieri dal Monte, capitano delle lance spezzate di Sua Eccellenza, il Signor Montino dal Monte, il Signor Cerbone dal Monte, il Conte Antonio Landriano, il Conte Iseppo Landriano, il Conte Ascanio Gonzaga: tutti uomini da governo e da potersi adoperare in ogni bisogno. E questo intertenimento, ch'egli dà ad alcuni soldati di qualità, parte è per volontà e parte per una certa obligazione che gli par avere, facendo questa professione che han fatta tutti i suoi passati, che quella casa sia come ricetto d'uomini di valore; de' quali, che han levato le insegne diverse volte, ho inteso ch'egli n'ha trenta e più. (...)

Mocenigo's relation in 1571[1]

"Relazione del Signor Lazaro Mocenigo. Ritornato da Guido Ubaldo di Urbino. L'anno 1571."

[p.183 (beginning)] Serenissimo Principe, eccellentissimi e gravissimi Signori, dovend'io, secondo l'ordinario degli altri ambasciatori, far relazione a Vostra Serenità e alle Vostre Signorie eccellentissime di tutto quello che nella mia breve legazione al Signor Duca d'Urbino ho possuto notare degno dell'intelligenza sua, mi sforzarò accomodandomi alle presenti occorrenze, nelle quali non è bene spendere il tempo inutilmente, di lasciar tutte le cose superflue, di toccar, come si suol dire, solamente quelle delle quali se ne possi avere facilmente vognizione, e, attendendo sopra ogni altra cosa alla brevità, procurerò di appresentar alla Serenità Vostra e alle Vostre Signorie eccellentissime

[1]Segarizzi writes in his apparatus: "Alle nozze di Francesco Maria, primogenito di Guidobaldo II, Duca d'Urbino, con Lucrezia d'Este, sorella del Duca Alfonso II (9 gennaio 1571), la Repubblica fu rappresentata dall'ambasciatore straordinario Lazzaro Mocenigo."

principalmente quelle, dalla notizia della quali io pensi che si possi in questi importantissimi bigogni trarne qualche giovamento.

[p.186] L'entrata di questo Principe, fra possessione, gabelle ed altre sorti di rendite, è intorno a 100.000 scudi; e, quando volesse aggravar i suoi popoli, non è dubio alcuno che ne caverebbe molto maggior somma. Ma, volendo seguire il costume de' suoi maggiori, di attender principalmente alla conservazione dell'amore de' suoi popoli, si contenta di lasciarli in questi termini e vivere egli con manco denari.

[p.188] Ha avuto Sua Eccellenza sei figlioli: doi figliole femine naturali, una legittima nata della Duchessa di Camerino <Giulia Varana, prima moglie di Guidobaldo II>, e con la presente Duchessa <Vittoria Farnese> il Signor Principe e due figliole femine. Delle figliole naturali la prima fu maritata in primo matrimonio al Conte Antonio Landriano: ora è maritata nel Signor Pietrantonio da Lunà, gentiluomo milanese, ricco e Signore di castelli. L'altra è moglie del Signor Guid'Ubaldo da Monte del signor Renier e nipote del Signor Montino, che serve al presente alla Serenità Vostra. La figliola della Duchessa di Camerino, che si chiama Donna Virginia, fu nel primo matrimonio maritata nel Conte Federigo Buoromeo, nipote di Papa Pio IV, il qual pontefice diede intenzion al Signor Duca, facendo questo matrimonio, di investrila nel Ducato di Camerino, ch'era posseduto dall'avo; ma morì il Conte Federigo senza che il Papa avesse fatta alcuna resoluzione. Si trovava al presente maritata questa Signora nel Duca di Gravina, Principe di molta stima nel Regno, di casa Orsina; la quale nel parto d'una figliola se n'è morta, con grandissimo dispiacere di Sua Eccellenza, che l'amava cordialissimamente.[1] Ha lasciato per testamento erede universale di tutte le sue ragioni il Signor Duca, suo padre; e questo è stato detto // importar al presente, tra gioie, denari ed altro, il valsente intorno a 150.000 ducati. Delle figliole della presente Duchessa ne ha maritata Sua Eccellenza la maggior <Isabella della Rovere> nel Signor Principe di Bisignano,[2] Principe de' maggiori di tutto il Regno, di casa Sanseverino, e ricco di più di 100.000 scudi d'entrata, ma con grandissimi debiti; la quale è molto amata dal marito, ed è principessa graziosa e piena di bellissime qualità, ed ha nome donna Isabella. L'altra figliola, che si chiama Donna Lavinia è ancora molto giovanetta, ma assai bella e mostra aver gran spirito. Il Principe, che ha il nome dell'avo, Francesco Maria, è d'età d'anni 25, di aspetto molto grazioso e di vivissimo ingegno. Si dà molto alli essercizi del corpo, come al giocar della palla, all'andar a caccia, a

[1] Virginia della Rovere died in 1571.

[2] The marriage between Isabella della Rovere and Niccolò Bernardino Sanseverino took place in 1565.

piedi ed altri simili essercizi, per abituarsi alli incommodi della guerra, disegnando Sua Eccellenza di seguir anch'egli il mestier dell'armi; e tanto gagliardi sono questi suoi essercizi e così continui, che molti dubitano che non gli abbino con tempo a nuocere la vita. Si diletta di cavalli, de' quali ne ha in gran copia, e cavalca e giostra molto leggiadramente. Studia, è intelligente delle matematiche e delle forificazioni, e insomma si diletta di tutte quelle cose che veramente sono appartenenti ad un Principe. E' amato da tutti i popoli per rispetto delle sue onoratissime qualità e della sua gentilissima natura; ma invero, dopo che è stato in Ispagna, pare che abbai appreso alquanto di quei termini spagnoli. Ha preso, come sa la Serenità Vostra, la Signora Donna Lucrezia d'Este per moglie, sorella dell'eccellentissimo Signor Duca di Ferrara, principessa di bellissimo aspetto e piena di grazia e di maestà, ma che ha intorno a 37 anni, e però pare che poco si convenga all'età del Principe, che non ne ha più di 25. Ed invero, serenissimo Principe, eccellentissimi Signori, benché questa principessa sia dotata di bellissime qualità, non è però, per rispetto dell'età, di satisfazione né al Signor Principe suo marito, che l'avrebbe voluta piú giovane, né a tutta quella corte, perché ognuno teme grandemente, e con ragione, che n'abbia da loro a nascer figlioli. (...)

[p.190] È stato, come sa la Serenità Vostra, Sua Eccellenza al servizio di questo eccellentissimo dominio con titolo di governator generale, e dal pontefice fu fatto capitano generale della Chiesa. Si trova ora Sua Eccellenza al servizio del Re Filippo <II> con titolo di capitano generale delle genti di Sua Maestà cattolica in Italia, e ha di piatto scudi 12.000. Oltre di ciò, le vengono pagate da esso serenissimo Re 100 celate e 100 uomini d'arme: li leggeri sono in essere, ma non gli uomini d'arme; per il pagamente de' quali e per il trattenimento de' capitani sono a Sua Eccellenza mandati ogni anno da Sua Maestà cattolica 35.000 scudi in groppo, li quali sono distribuiti come più piace a Sua Eccellenza.

[p.191] Vive Sua Eccellenza <Duca Guidobaldo II> assai allegramente, dandosi piacere con i suoi gentiluomini, e con quelli, li quali sono continuamente appresso la sua persona e pochissima parte del giorno si allontanano da lei: sono prima il Signor Pietro Bonarelli, il quale è sopramodo caro al Signor Duca ed ha il titolo di Capitano generale della Cavalleria, ed è quello che può ogni cosa appresso Sua Eccellenza, con qualche risentimento del Principe; il Conte Fabio Landriano, che ha una nipote del Duca per moglie; il Signor Rainer del Monte, che è suo Capitan generale de' Fanti; ed il Conte di Montebello che ha per moglie una sorella del Conte Pietro predetto. (...)

[p.192] Spende Sua Eccellenza molto largamente, ed oltre il trattenere un'onoratissima corte, anzi più corti, cioè la sua, quella del

Principe, della Duchessa e della Principessa, qual tutte son piene di molti gentiluomini, vuole alloggiare tutti i personaggi che passano per il Stato suo, il numero de' quali alla fine dell'anno si trova esser grandissimo. Dona a' suoi servitori e, quando ha preso la protezione e l'amicizia d'una persona, non cessa mai di accarezzarla e magnificarla, tanto che molto volentieri ognuno concorre a quella corte. (...)

Zane's relation in 1575 [1]

"Relazione di Messer Matteo Zane. 1575."

[p.199 (beginning)] Per la morte de l'illustrissimo Signor Guidobaldo Duca d'Urbino, ch'era in età di 60 anni, è successo erede del Stado e de' beni paterni l'illustrissimo Signor Francesco Maria, unico figliuol suo, il quale ha voluto Vostra Sublimità onorar con questa ambasciaria, per obligarnelo con questo solito ufficio di compimento a continuar in quell'affezione ed osservanzia ne la qual sono sempre stati i suoi maggiori verso questo serenissimo dominio, e particolarmente Francesco Maria, suo avo, del quale esso porta il nome. (...)

[p.202] Vi posson esser in quel Stado intorno 150.000 anime, contando ogni condizion di persone, ma da fatti arivano a 40.000. Fra li popul d'Urbin e di Pesaro vi è emulazion e gran guerra da molto tempo, ma non è però tale che in alcun modo possa perturbare il giusto posesso del Principe né la pacifica quiete de' sudditi. (...)

[p.205] Ha Sua Eccellenza duoi secretari principali, uno de' quali è deputato alle cose di giustizia, l'altro a quelle di grazia e ha li negozi e facende particolari di Sua Eccellenza; e questo è il Secretario Veterani[2], ministro reputato assai e benissimo conosciuto.

[p.208] Ha lasciato il Duca Guido Ubaldo intorno 150.000 scudi di debiti a diversi particolari con qualche interesse sopra, ma a l'incontro ha lasciato delle gioie e una ricca guardaroba d'addobamenti del palazzo. (...)

[p.212] Il Signor Duca <Francesco Maria II> è in età di 29 anni e di buona disposizion di corpo. Fa profession di Principe giusto ed è religioso molto. Procura Sua Eccellenza che li sudditi suoi vivano col medesimo zelo di religione, e lo Stado era visitado al presente, per ordine del Pontefice, dal vescovo Ragazzoni, con molta sodisfazione di Sua Eccellenza e grandissima laude di quel prelato. Si diletta di esercizi nobili, massime di cavalcar, per occasion di che Sua Eccellenza

[1] Segarizzi writes in the apparatus: "In occasione della morte di Guidobaldo II della Rovere, duca d'Urbino, il Senato inviò al nuovo Principe, il figliuolo Francesco Maria, l'ambasciatore straordinario Matteo Zane"

[2] Veterani *correxi ex* Volaterani

mantien una bella e numerosa stalla. È studioso e litterato assai, e fa profession soprattutto d'arme e d'esser soldato. Nella sua corte vi è sempre alcuna persona segnalada in arme ed in lettere, e qui si fa profession d'una esquisita creanza e di esser cortigiani perfetti: il che è uso antico di quella corte, confirmato tanto maggiormente adesso, quanto che il Principe è stato alla corte di Spagna. (...)

[p.215] La Signora Duchessa Lucrezia, moglie di Sua Eccellenza e sorella del Signor Duca di Ferrara, è Signora di bellezza manco che mediocre, ma si tien ben acconcia, avendone forse il bisogno per la sua età, che passa li 40 anni; e questa sproporzion d'anni col Signor Duca è causa che tra loro non vi sia quel amor, che suol essere tra marito e moglie, quando vi è la medesima convenienzia d'età; e per l'istessa causa delli anni si despera quasi di poter veder da questo matrimonio figliuoli. Il che quando avenisse, lo Stado, che è feudo de la Chiesa, s'unirebbe con quello di Sua Santità, ogni volta che non fusse da lei investido prima in persona d'altri.

I.2 Ranieri dal Monte

Ranieri was the founder of the Pesaro-branch of the Marchesi del Monte (di Santa Maria) and has to be considered the guarantor of the rise of the dal Monte in the Duchy of Urbino to one of the most influential families. The first subsection reports the dedicatory letter of D. Atanagi's *Lettere facete*, the second the *Vita* of Ranieri dal Monte in Bonamini's *Abecedario degli architetti e pittori pesaresi*; the last subsection presents documents that contribute to a better comprehension of Ranieri's life – and therefore of the milieu in which Guidobaldo grew.

I.2.1 The dedicatory letter of Atanagi's *Lettere facete*

The work *Lettere facete et piacevoli di diversi grandi huomini et chiari ingegni* of D. Atanagi is dedicated to Ranieri dal Monte. The long dedicatory letter contains precious information both on the history of the dal Monte family in general, as well as on Ranieri and Guidobaldo in particular.[1] The following transcription occupies its final part which speaks about Ranieri himself, and in this context also about Guidobaldo:

(...) Seteci finalmente Voi, Illustrissimo Sig. Raniere, del quale, per non cantar le laudi Vostre a Voi stesso, dirò sol questo, che a Voi piutosto è mancata la occasione di mostrare il valor vostro nella guerra, che l'anonimo et l'accesa volontà che n'avete avuta: et che, se

[1] D. Atanagi, *Lettere facete et piacevoli di diversi grandi huomini et chiari ingegni*, Venezia, Bolognino Zaltieri, 1561. Revised second and third edition respectively in 1582 and 1601.

da invidiosa fortuna non vi fosse stata chiusa la strada d'entrare in quel campo di gloria, Voi per commun giudicio di tutti avreste senza alcun dubbio nonché arrivati, ma di gran corso trapassati i vostri antecessori. Ma quello che è stato et è in poter vostro, Voi in ogni Vostra attione vi sete dimostrato et vi dimostrate non meno giusto et prudente che forte et temperato: mansueto, amator de' poveri et de' virtuosi. Catholico, et pieno di vera religione. Et nella servitù di 33 anni fatta al virtuosissimo et giustissimo Duca Guidobaldo avete dato alla Eccellenza Sua tanti pegni d'umiltà, d'obedienza, di diligenza, di sincerità, d'amore, et di fede nel suo servigio, senza mai per accidente alcuno discostarvi pur un passo dal lato et dal voler suo né riveder pur una volta in tanto spatio di tempo, il padre, la casa, et le case vostre, essendo massimamente gentiluomo di dominio, come sete.
Che meritamente Ve n'avete guadagnato con la intera possessione de la sua gratia il d'un nuovo Achate, d'un Efestione et d'un Mecenate nuovo: et insieme la laude, che tanto, et sì giudicioso Principe, gloriandosene, pubblicamente V'ha dato: cioè che mai non V'ha sentito fare officio di nocumento ad alcuno: ma che avete giovato et giovate sempre a chiunque ricorre a voi: et che sete stato et sete il vero mediatore tra la Eccell. Sua e i suoi vassalli: laude certamente grande, laude rara, et da pochi in ogni età conseguita. Et oltre a ciò avete meritato che S. Eccell. in riconoscimento di tanta servitù, et di tante vostre virtù, oltre all'avervi deputato già Capitano de le sue Lance Spezzate, et Generale delle battaglie del suo stato, et in particolare Governatore della città di Pesaro, vi doni appresso il popolato, buono et bel castello di Monte Baroccio, et al Sig. Guidobaldo Vostro primogenito figliuolo, giovanetto d'altra speranza, dia per consorte la Illustrissima Signora Felice Rovere sua figliuola.
Ora, per tornare al mio primo proposito, da che giusta affettione m'ha forse troppo dilungato dalla dedicazione di questo libro, io Vi prego, Illustrissimo Signor mio, che Vi piaccia d'accettarlo cortesemente: et di conservarmi nella buona gratia Vostra: et, se io non oso troppo, di ricordarmi talora opportunamente in quella di Sua Illustrissima Eccellenza, per quel che io Le sono, umilissimo, et devotissimo servitore.
Di Venetia a 22 di marzo 1561.
Di V. Illustriss. Signoria
Affettionatiss. et obligato servitore,
Dionigi Atanagi

I.2.2 Bonamini's *Vita* of Ranieri

An informative biography of Ranieri is contained in the work "Abecedario degli architetti pesaresi" of Domenico Bonamini (1760-1790ca.), conserved at BOP, ms 1009.[1] The *Vita* of Ranieri is exposed on the pages 53-57:

> 1550 Del Monte Raniero Marchese di Montebaroccio
> Dell'origine della nobilissima famiglia de' Marchesi del Monte di Santa Maria parlano troppi scrittori onde a me sia necessario riportarne le parole. Veggasi per tutti Dionigio Atanagi nella dedicatoria al *Libro delle lettere facete e piacevoli* (presso me). Conviene però ch'io faccia vedere come questa nobil famiglia dir si possa pesarese, essendosi propagata in tanti rami, alcuni de' quali andarono a Firenze, altri a Perugia, a Venezia, in Ancona e questo anche in Pesaro.
> Girolamo di Raniero del quondam Cerbone del Monte, padre di costui del quale ora imprendo a dire quanto abbia valuto nell'architettura fu quello che, avendo sposata una certa Ippolita figlia di Boso de' signori di Santa Fiore, venne ad abitare in Pesaro ed ebbe nell'anno 1517 questo figlio e Montino, del quale ancora farassi menzione. Raniero in sua gioventù diedesi ai servigi di Francesco Maria I che lo amò moltissimo ed ammirando la dolcissima di lui indole lo diede più in qualità di compagno che di cameriero al suo figliolo Guidubaldo, facendo studiar ambedue sotto i medesimi maestri.
> Cresciuti insieme, affezionaronsi l'un l'altro in guisa e massimamente Raniero a Guidubaldo che nello spazio di 33 anni che lo servì in qualitù di gentiluomo di camera, di Capitano delle // lancie spezzate e Generale della battaglie del suo stato e particolarmente, se è vero ciò che asserisce l'Atanagi, in Governatore della città di Pesaro, altro non fece Raniero che giovare a tutti ed essere vero mediatore tra l'amoroso sovrano ed i fedeli suoi sudditi. In contracambio di tanti servigi profuse Guidubaldo sovra la nobil famiglia Del Monte le sue beneficienze, tra le quali non fu piccola quella d'investirlo l'anno 1543 del marchesato di Monte Baroccio, come si ricava dal *Libro I de' Decreti*, cc. 183 e 186, e da una lapide nella nostra chiesa, anzi sagrestia di San Carlo, dove si fa menzione di Minerva Pianosi, figlia del cavalier Sebastiano, che fu moglie di questo Raniero essendo stata dotata di scudi 15000, somma assai eccedente per quei tempi. Questa Minerva gli partorì 13 figli, nove femine e quattro maschi, e quantunque Raniero come ognuno può credere fosse affollato, e per gli affari domestici d'una sì numerosa figliolanza e per gli altri del suo serenissimo padrone, tuttavia coltivò sempre le lettere e particolarmente i studi mattematici,

[1] The manuscript is transcribed and published in D. Bonamini, *Abecedario degli architetti e pittori pesaresi*, ed. by G. Patrignani, in "Pesaro città e contà, VI (1996).

ne' quali rapigli poi Guidubaldo il figliuolo la palma.
Oltre d'aver Raniero militato in guerra viva, di che giù cantò Bernardo Tasso nel canto 115 dell'*Ama//digi* dicendo:

> Perché Raniero il capitan maggiore
> della gente da piede italiana
> Signor Del Monte, allor luce e splendore
> di tutta la milizia di Toscana,
> aveva rotto per suo gran valore
> la buona fanteria scuota et ispana
> ed ucciso Leonzio con Brimarte
> tutte le genti lor disperse e sparte

compose anche due libri sopra l'architettura militare, lo che fu cagione onde qui fosse tra i celebri architetti anoverato. Esiste questo manoscritto nella libreria del Conte Giuseppe Castracani di Cagli, che fu erede non solo d'una porzione de' beni de' nostri Marchesi del Monte, ma anche de' loro numerosi manoscritti e degl'instromenti mattematici e de' legni incisi per fare i rami da tirare per le stampe.
E' unito a questo codice intitolato *De architettura militari libri duo* altra opera dell'istesso Raniero *De astrologia libri tres* e tra l'uno e l'altro codice sono pagine 368: così per asserzione del Lancillotti dello Staffolo, che tutto ha veduto concernente a questa illustre famiglia e gentilmente a me ne dette le sue relazioni. // M'assicurò ancora questo Signore che fra i codici suoi possedeva ancora un altro manoscritto di Raniero intitolato *Narrativa della morte dell'illustrissimo et eccellentissimo Francesco Maria Feltrio dalla Rovere Duca d'Urbino*, come anche un altro *Fatti del Duca Guidubaldo*, codice semilacero presso i Signori Castracani.
Morto nell'anno 1574 il Duca Guidubaldo, si ritirò Raniero in Monte Baroccio e lì finì i suoi giorni li 12 gennaio 1587.
Ecco ciò che di Montino, fratello di Raniero, lasciò scritto Dionigi Atanagi: "Il Signor Montino, altre a quello che potrei dire dell'ingegno dell'eloquenza e dell'altre sue nobilissime parti, ha in modo acompagnato la prudenza col valore e la cognizione del governo civile con la notizia dell'arte militare che, come nell'uno e nell'altro si fa conoscere ogni dì più per degno creato e servitore del prudentissimo ed invittissimo Duca Francesco Maria, così per questo e per quello ha indotto il sapientissimo e valorosissimo Duca Guidubaldo ad averlo sempre in gran conto e ad aonorarlo in tutte l'ocasioni: sì come fece allora che Sua Eccellenza ebbe il governo generale del Serenissimo Senato Veneziano dandogli il suo stendardo generale; e quando poi da Giulio III // Sommo Pontefice Sua Eccellenza fu fatto Capitano generale di Santa Chiesa, costituendolo suo Maestro di campo generale, ed ul-

timamente mandandolo ambasciatore a Roma a Papa Paolo IV, nel quale officio continua ancora con somma laude sua e satisfazione di Sua Eccellenza appresso il Santissimo Signor nostro Pio Papa IV." Fu scritta tale lettera dedicatoria dall'Atanagi nell'anno 1561, 22 marzo. Di Montino ancora fece menzione l'istesso citato Bernardo Tasso nell'*Amadigi*, canto 100, dicendo

> Raniera del Monte e Montin suo fratello
> io veggio presso al glorioso duce etc.

I.2.3 Sources for a reconstruction of Ranieri's biography

Ranieri was born from Girolamo del Monte Santa Maria (1495-1540), at those times the Marchese, and Ippolita Sforza, daughter of Federico I Count of Santa Fiora and of Bartolomea Orsini, widow of Federico Farnese and of Alessandro Gonzaga. At the age of eleven, he was sent by his father to serve the Duke of Urbino Francesco Maria della Rovere and the Prince Guidobaldo as knave,[1] where also his brother Montino served.[2] The following letter, written in 1530 by Girolamo del Monte Santa Maria to Guidobaldo della Rovere, is a testimony of Ranieri's and Montino's services for the Prince.[3]

> Ill.mo S.r Padron obs.mo
> Avemo fatto sopraseder qualche dì più il Montino: si rispecto al cesareo exercito quale è stato vicino a noi. Si etiam per essar tornato il S.r Franc.o nostro fratello da Firenze: Ora ritorna delli servitii di V. S. Ill.ma.
> Quanto a Ranieri: ne scrivo al Venitiano, qual referirà a quella.
> Alla qual sempre come buon servitor mi offero et racomando. Ex Monte S.tae Mariae. Die XII Ottobris M:D:XXX
> Di V. Ill.ma S.ma
> Servitor Hieronimo dal Monte

Not much information about Ranieri seems to be extant concerning the successive years. Apparently he had become a precious intimate of Guidobaldo II della Rovere, since 1538 Duke of Urbino, which is testified by the numerous privileges conceded to him: he was assigned mills, he was named Count and he was given the town of Monte Baroccio as county. The next document is (a copy of) the deed of enfeoffment of his feud in 1543:[4]

[1] Cf. BOP, ms 758.

[2] For further information on Montino, see Appendix II, I.2.2.

[3] Cf. ASF, Ducato di Urbino, I, 236, fol. 1078r. On the envelope, fol. 1079v, the recipient is specified: "Allo Ill.mo S.r Guidobaldo Feltrio del<la Rovere> S.r et Patron obs.mo"

[4] The copy of the deed of enfeoffment is contained in an archival unit conserved in ASF, Bourbon del Monte, 5, pp. 611-623. It consists of about 1100 pages, has the dimension of

Diploma d'Investitura del Castello di Monte Baroccio, concesso dal Duca Guidubaldo II Duca d'Urbino, al Marchese Ranieri del Marchese Girolamo del Monte S. Maria nel 5 settembre 1543:

Guius Ubaldus Feltrius de Ruere Secundus Urbini Dux, quartus Montis Feretri, Durantis Comes, Senogaliae, Pisaurique Dominus Illustrique Domino Raineris fili Domini Hiieroniimi de Marchinibus de Monte Santae Mariae Comiti Montis Barotii.

Salutem ac sincerae dilectionis affectum. Beatae quidem sancteque inter mortales ageretur. Si bonorum morum pariter ac vitiorum exactissima ratio haberetur benemeriti enim viri, condigno suae vitae praemio, ne defraudarentur et ignavissimi quique ad immitandas eorum probitates excitarentur.
Nobis autem hoc semper [soidi] fuit potissimumque, ut de illis benemeremur, quos erga nos fide inconcussa ac servitute sincera, diligente esse animadvertemus, tum ut labor et merita ipsorum sine praemiis uti decet, non dimicteremus, tum etiam, ut alios exemplo eorum ad talia, accurate peragenda excitaremus.
Qua propter cum tu virtutum ac probitatum tuarum sincera servitute moltos nobis annos praestita praecipuaque fide et observantia erga hos sedulo exhibita periculum feceris, tuaque ob haec et morum, dexteritatem, ac generis et prosapiae nobilitatem undique se se offerant merita, te ne dum amandus, sed munificentia nostra, et liberalitate una cum posteris tuis exornandum, decorandumque duximus.
Itaque hoc publico documento, animo tamen efficacius amo//ris erga te, nostri post hac quandocumque facultas dabitur testimonium exibendi te ac descendentes tuos, ut infra exornamus.
Quia videlicet motu proprio et ad nullius per te nobis oblatae petitionis instantia[m], sed ex mera ac deliberata animi scientia et de nostrae potestatis plenitudine, etiam absoluta et suprema, ac aliis omnibus, iure modo et forma, quibus melius, validius, et efficacius de iure potuimus et possumus intervenientibus omnibus tam iuris quam facti solmnitatibus in similibus necesariis ac alias adhiberi solitis et consuetis.
Primo, et ante omnia, ad efficatiorem infrapositionem effectum omnium ad plenius robur maioremque fimitatem Castum Montis Barotii nuncupatum Civitatis Pisauri, ab ipso comitatu annexioneque pro comitatu et ab ipsa civitate, eiusque superioritate una cum territo-

about 30x40 cm^2, with a wooden cover and metal ornaments; its weight is about 10 kg. It is entitled "Documenti sopra i quali è formato il Sommario Cronic.o Genealogico della famiglia de Marchesi Bourbon del Monte. Parte III". The text of the enfeoffment deed terminates with the comment: "Cartapecora [brighe] nell'Archi.o Dom.sco della Branca del Monte d'Ancona, e copia semplice in quello della Branca di Firenze filza prima fascetto II n.p 28."

rio et pertinentiis suis ab omni mero, mixto imperio gladii potestate et quacumque iurisditione, et subiectione dictae civitatis Pisauri, cui quovis modo, vel iure subesse hactenus diceretur seu reperiretur, tam ex privilegio, quam ex consuetudine etiam praescripta, seu aliter quomodocumque habita, indulta, et acquisita separamus, segregamus et eximimus secernimus, et liberamus, ac separatur, segregatur. Exemptum et liberum penibus et omino facimus decernimus, et esse volumus et mandamus, ita ut deinceps, et imposterum huius nostrae separationibus vigore, Castum ipsum Montis Barotii cum suis Territoriis, pertinentiis, confinibus, et iuribus, sit, et esse dignoscatur unum corpus per se separatur, liberum et exemptum, ab omi mero, mixto imperio gladii potestate // et omnimoda iurisdictione praefatae civitatis Pisauri et nostrorum [inibi] officialius etiam Capitanei Generalis Potestatis Locumtenentis et aliorumquorumcumquavis auctoritate, et potestate furigentiu[m] et specialiter et ex presse, a quod ab Statuto Pisaurensi in Volumine dictae Civitatis Statutorum in Libro Civilium n.o 100, sub Stab.a, quoad possessiones et praedia no dictate omnia praedia et possessiones, eiusdem Castri Territorio, sicut [residuum] Communitati dictae civitatis fore et esse tributaria, pro impositione collectarum et factionum omnium, tam ordinariarum, quam extraordinariarum, et pro illis expresse obnoxia, et hipothecata, cui Statuto ad utilitatem dumtaxat infrapostae nostrae concessionis, motu[m] scientia potestateque, similibus derogamus et pro derogato haberi volumus et mandamus.
Eidemque Castro ac Loco praesenti nostrae investiturae et subinfeudationis, durante effectu, et personis inferius nominandis et compraehendis, seu altera ex eis superstitibus, et ind.o loco dominantibus merum et mixtum imperium gladii potestatem, et omnimodam iurisdictionem, ac plenam superioritatem, tam in civilibus quam in criminalibus et mixtis causis et negotiis, damus, concedimus et assignamus. Et successive praemissorum meritorum tuorum intuitu et qui in fide servitute et debit erga nos obedientia et subiectione, te Posteritatemque tuam infrapostam tui exemplo perseveraturam non dubitamus, et eo propituis et diuturnius, quo maiorem animi nostri in te et eam munificentiam et fructum ex praesenti nostra concessione experiens et in dies percipies perensis evaginati in manibus tuis, per nos traditionem, per nos succes//soresque nostros, iure nobilis honorifici et insignis feudi damus, concedimus, investimus, subinfeudamus, et assignamus illustri Domino Rainerio, flexis genibus, coram nobis constituto, praesenti, et recipienti ac stipulanti pro te omnibusque filiis tuis et descendentibus masculis, legitimo matrimonio per recta lineam perpetuo et in infinitum gradum nascituris, iure tamen progeniturae inter eos semprer salvo praedicum Castuum Montis Barotii.

Sic ut praemissus est [disiunctur] et separatur, cum suis pertinentiis territoris, iuribus universis, Palatis, et Casamentis omnibus, homagiis, et mero ac mixto imperio, omnimodaque iurisdictione, et iurisdictionis ac dominii et signoriae plenitudine, ac gladii potestate, tamen in civilibus, quam in criminalibus, ac mixtis, ut supra assignatis, ac cum honoribus, [franchitiis], libertatibus, praeeminentiis, possessionibus, proprietatibus, imbottatis, datiis, tertiariis, et introitibus quibuscumque fluminibus, littoribus, ripis aques, aquaeductibus, pensionibusque, molendinorum , venationibus, piscationibus, furaris, fornacibus, pratis, buschis, herbis, pascuis, nemoribus, montibus, ipsorumque Montium Culminibus, tesauris, lapidicinis auri, argenti, eris, metallorumque omnium, lodinis, gemmis, lapidibus, et aliis quibuscumque regalibus iuribus, et praerogativis, quae inde et super dicto Castro et eiusdem territorio et pertinentiis quomodolibet et qualiacumque ex illis per nos ipsos percipi et haveri potuissent, et ad nos quovismodo spectantibsu, et pertinentibus ; et quae qualitercumque spactare, vel perti//nere, nunc et in futurum possent [libero] tamen, et ab omni gabellae, passagii sue pedagii slutione immuni, ac fianco remanente transitu, transeuntibus et itinerantibus per dictum territorium Montisbarotii, ac omnibus ibidem occasione praedicta quandocumque forsitan exigendis Camerae nostrae Civitatis Pisauri perpetuo reservatis ne contingat viatores et per transeuntes cum rebus et mercibus propter multitudines insolitarum gabellarum, iter rectum divertere a dicta Civitate Pisauri et Forisempronii, et alio iter flectere, et ita utriusque Civitatis passagii gabellae praeiudicium fieri ; excepta etiam gabella salis et salis venditione cui per hanc nostra concessione nullum fieri proiudicium volum.

Nec non reservatis in dicto Castro eiusque territorio et iurisdictione alloggiamentis gentium armigerorum et militum tempore belli dumtaxat in nos ipsos et statutum nostrum (quod Deus avertat) In reliquis autem omnibus salvis praemissis plenum dominium sue quasi, et omnes actiones reales, personales et mixtas tam utiles quam directas, ac omnimodam potestatem baliam au<c>toritates et superioritates nostras inde pro hac supradicta Castra eiusque territorio competens et competentes ac pertinentes et pertinentia competituras et competituram iure etiam debitorum fidelitatis et maioritatis nostrae semper salvo et reservato in te Illustrissimus Dominus Raiinerius, ut supra recipientem, cedentem et transferentem, ita ut tu, et caeteri supranominati et compraehensi illam eamdem habeas, et habeant iurisdictionem et omnimodam potestatem regalia, Signoria, merum et mixtum imperium // gladii potestate ac plena iurisdictionem tam in primis quam in secundis et teriis cuasis civillibus, criminalibus et mixtis, huiusmodique causarum cognitione definitione t delegatione etiam cum clausula

etraiudicialiter, et solafacti veritate inspecta.
Vicariique et Officialis iura reddituri pro tui et descendentiorum ut praeferturii libito voluntatis deputatione, debitaque dilectorum omnium quantumcumque gravissimorum et atrocium animadversione, usque ad sanguinem et vitae ac bonorum adeptionem, et confiscationem inclusive in casibus tamen a iure permissis bonorumque huiusmodi, ut supra confiscandorum pro vobis retentione, et appropriatione, etiam cum privilegiis et praelationibus fisci iquam et quae ac veluti et quemadmodum habui pemus et potuissemus nos ipsi ante praesentem subinfeudationem.
Et nichilominus ut meliori et clariori praefulgeas dignitate, te Illustrissimum Dominum Rainerium et alios in dicto feudo successuros in Comites Dominos Patronos praefati Castri Montisbarotii et illius Dominii et Signoriae facimus, constituimus, creamus, et erigimus, ac decoro titolo et denominatione perpetuo illustramus nobilitate et insignimus ita ut deinceps dicti Castri Montisbarotii Comites nuncupari ac nominari, et scribi merito valcatis omnibusque favoribus, immunitatibus, antelationibus, privilegiis, prerogativis, gratiis, quibus aliabus, nostri Comites [funintur] et gaudent. [p.616] (...)

[p.623] In quorum omnium et singulorum perpetuam fidem praesens privilegii munimentum per infrapositum secretarium nostrum confici manus nostrae eiusdemque Secretarii subscriptionibus communitum, et nostri soliti maioris sigilli appensione roboratus iussimus et fecimus praesentibus magnificis,e t nobilibus comite Antonio Landriano de Ancona, Capitano Francisco Connegrano de Mantua, Domino Johanni Baptisti Barcella Forisempronii et Domino Federigo Bianchino Urbinati nobilibus familiaribus nostris testibus, ad praedicta omnia adhibitis, accertibisque.
Datum Urbini die quinta Septembris 1543
Guid'Ubaldo Jacobus Angelius Secretarius

Nine years later, the enfeoffment was confirmed and Ranieri was additionally conceded the right to join "della Rovere" to his family name:[1]

Conferma della detta investitura di Monte Baroccio, fatta dal suddetto Duca Guidubaldo al suddetto M.se Ranieri, con aggregarli alla sua famiglia della Rovere e dandoli l'uso del cognome nel 4 Aprile 1552.

Guidus Ubaldus secundus Feltrius de Ruere, Dux Urbini IV, Pisauri Senogalliaeque Dominus, Montis Feretis // ac Durantis Comes, et

[1]Cf. ASF, Bourbon del Monte, 5, pp. 623-625.

Sereni Veneti Dominii Guvernator Generalis Ill.mi Domino Raiinerio de Marchionibus de Monte S. Mariae Comitis Montisbarocii salutem.

Ut firmitas firmitati addatur, utque tanto magis de animi erga te nostri perseverantia appareat, cuius sprofecto quotiescumque occasio dabitur maiora et graviora signa et effectus libentissime domonstrabimus presentium tenore, omnia et singula in supradictis paginis sub infeadationis privilegio et concessionibus datis, et expeditis, in civitate Urbini sub die quinta Septembris anni 1543 contenta, ac decripta prout [iacetit] de verbo ad verbum confirmamus et approbamus.
Nec non de novo concedimus prae[sertim] ac signanter, ut eisdem subinfeudationibus, et concessionibus accedat et insit omne id totum, et quicquid auctoritatis continetur in facultate nobis attributa per investituras totius nostri status renovatas ac factas sub anno 1545 quinto kalend. Maii Ssmo et beatissimo felicis recordationis Paulo tertio Pont. Max.o in quibus inter caetera ultra id quod nobis de iure licebat et permissus erat, concedibus expresse et nominat[is/im] facultas huiusmodi Castra, Oppida et Terras infeudandi. Quodquidem nunc facimus ut supra, ad hoc ut validitas validitati et iura iuribus tuis et praedictorum tuorum efficaciora addantur.
Et ut [apertius/assertius] liberaliori nostro erga te et praedictos descendentes tuos animo appareat, concedimus et gratiose largimur tibi et filiis, et descendentibus tuis praedictis facultatem et potestatem, ut in posterum denominari appellari et describi valeatis et possitis de mea domo et familia de Ruere, ex nunc eterni, te et praedictos eidem familiae, et domui nostrae ag//gregamus et connumeramus et aggregari et connumerari volumus, et mandamus perinde ac si ex personi in ipsa naturaliter comprensis geniti et procreati fuissetis, mandantes omnibus et quibuscumque ut in futurum te et praedictos pro talibus habere, tenere et vocare debea[tur] omnino.
In quovim fidem praesentes fieri iussimus per infra[post]um et eundem secretarium nostrum et maiori nsotro sigillo signari, eiusdemque secretarii nostri subscriptione muniri. Datum Pisauri 4 Aprilis 1552.
Iacobus Angelius Secretarius
Guidubaldo

The nomination as count permits to perceive the important position that Ranieri had gained at the ducal court. Yet, there were also other members of the court made count in those years. So, other assignments conceded to Ranieri are more enlightening in this regard: for example, his nomination as head the Duke's lifeguard ("lance spezzate"). Further, as the Venetian ambassador Badoer writes in his report in 1547,[1] he must have already been in the circle of the Duke's

[1]For a partial transcription of Badoer's report, see Appendix II, I.1.

closest intimates:

> Al servizio di Sua Eccellenza sono il Signor Ranieri dal Monte, capitano delle lance spezzate di Sua Eccellenza, il Signor Montino dal Monte, il Signor Cerbone dal Monte, il Conte Antonio Landriano, il Conte Iseppo Landriano, il Conte Ascanio Gonzaga: tutti uomini da governo e da potersi adoperare in ogni bisogno.

Ranieri's outstanding role and the Duke's high estimation of him, shared by the Duchess Vittoria della Rovere, is documented by the following letter written by the latter to his husband in 1548.[1] The Duke was staying in Venetian territory at that time, active in his function of General Captain of the republic.[2] Apparently Ranieri stayed with him, but turned sometimes and transmitted letters between Duke and Duchess.

> Ill.mo et Acc.mo S.or Consorte e S.or mio singul.mo,
> venendo il S.or Ranier da V.Ecc.a Dio sa quanto m'è stato caro e sapendo quanto Lei l'ama l'ho vissto con tanto mio contento quanto arei fatto il Duca mi fratello che principalmente per questo io desidero farli piacer sempre e di poi per esser lui figlio d'una cugina de la S.ra Duchessa mia madre com' penso.
> V. Ecc.za sappia siché, per molte cause ma la principale è quessta che Lei l'ama, io l'ho vissto e vederò sempre da fratello di quanto m'ha ditto da parte di V. Ecc.a io Le n'bacio reverentemente le mani, sperando in la bontà Sua sempre. Di A'gubio alli XXVII de gennaro nel XLVIII
> D. V. Ecc.a
> S.va e Am.ma consorte Vitt.a
> Farnese della Rovere

The next letter evidences also the particular relation between Ranieri and the little Prince Francesco Maria: the former seems to been a sort of substitute father for the little child in the absence of the Duke.[3]

> (...) Le bacio le mani di quessto comandamento ch' ma fatto fare l'imbasciata alla S.ra sorella, la qual desidera la tornata di V. Ecc.a.

[1] Cf. ASF, Ducato di Urbino, I, 109, fol. 153r. Attention has to be paid to the numeration, of which the archival unit presents two different systems: an overall one that numbers every folio, written with ink, and another, that counts every letter, with pencil. We refer, here and after, to the overall numeration.

[2] Duke Guidobaldo II does not seem to have passed much time at Pesaro between 1547 and 1549, given the conspicuous number of letters of the Duchess written to him in his absence, conserved in ASF, Ducato di Urbino, I, 109. From the end of 1549 to the end of 1550 there are no letters between Duchess and Duke. Thus, in this context, it seems plausible to assume that the absence of letters is owed to a sojourn of Guidobaldo II at Pesaro in this period.

[3] ASF, Ducato di Urbino, Classe I, 109, fol. 286r.

> Mo dopiamente l'una e l'altra sta ben e bacia le mani di quella cossi fa D. Virginia e sta sana col suo fratellino <Principe Francesco Maria> ch' tutto el dì vol scriver al S.or Padre e scrive benissimo com' V. Ecc.a vedrà per una sua al S.or Ranier. La S.ra Camilla sta assai ben', s'fa grossa. Io non manco d' quel ch' so d'acarezarla e avern' cura, e'l' fo con tutto el cor (...). Di Pesaro alli XVI di Novembre del Lta[1].

In the meantime, in 1544, Ranieri had taken Minerva Pianosi, daughter of the wealthy Tuscan merchantman Sebastiano Pianosi, for his wife. It seems that this marriage was contracted also with the mediation of the Duke, as the liaison with the influential Pianosi family additionally strengthened Ranieri's social-economical position.
In fact, "Cavalier" Sebastiano Pianoso seems to have had role of some importance in the political life of Pesaro and at court.[2] He is said to have been member of the Council of Pesaro from 1518, and the following extract of a letter between Duchess and Duke shows him besides the influential Ranieri and Montino:[3]

> (...) Al Cavalier Pianoso ho detto quanto V. Ecc.a me comanda, al S.or Montino l'ho scritto, mi scrive ch'ha risposto del tutto al S.or Ranier. (...)
> Di Urbino alli X d'Agosto del 1551

In 1545, one year after the marriage between Ranieri and Minerva Pianosi, their first child was born, Guidobaldo. As BOP, ms 758 tells us, his godfather was the Duke himself – also this fact is significant to comprehend Ranieri's outstanding position.

The following letter, stemming already from 1563, important also for dating Guidobaldo's stay at the university of Padua, reveals that Ranieri's position had not changed:[4] the Duke personally had approached an agent in the Venetian academical centre in order to ensure Ranieri's children the right to bear arms during their stay at Padua. Also Clusone, after the Duchess of Urbino, emphasises the affection shown by the Duke to Guidobaldo's father.

> Ill.mo et ecc.mo Sig.r mio sempre oss.mo,
> l'infinita benignità et cortesia con che V.S. Ill.ma si degna di commandarmi, non desiderand'io altrettanto in questo mondo cosa alcuna che occasione di poterLa servire, mi è infinitamente cara per veder la memoria che la Eccellenza Vostra conserva del Suo antiquo et amorevole

[1] "Lta" is the abbreviation of the Italian "Cinquanta", i.e. of 1550.
[2] For further information on Sebastiano Pianosi, cf. BOP, ms. 455 Tomo II, fol. 93v and BOP, ms 1063, fol. 365.
[3] ASF, Ducato di Urbino, Classe I, 109, fols. 319r-320r.
[4] ASF, Ducato di Urbino, I, 217, fol. 335r, autograph.

servitor: il perché conosciendo dalle Sue amorevolissime lettere l'affettione che porta, et il desiderio che tiene del bene del S.r Raniero mio antiquo et amorevole amico et Signore, per amor di V.S. Ill.ma et del S.r Raniero et Dio insieme, ricevendo io favor infinito et contento a poterLa servir, non mancherò in tutte le occasioni che, et con aiuto et consiglio potrò giovar ai figliuoli del detto Sig.r Raniero, che V.S. Ecc.ma nelle Sue mi raccommanda purché essi mi dimandino et adoperino et così in far lor aver la licenza di poter portar l'arme come in ogn'altra cosa che si rappresenti.
Et senza più pregando ogni felicità et contento a V.S. Ill.ma nella Sua buona gratia tutto mi dono et raccomando, pregandoLa a servirsi di me et addoperarmi in quelle cose che sono buono a servirLa, che mi farà favor singular et appiacere. Da Padova a XXV di Novembre 1563.
Di V.S. Ill.ma et ecc.ma
Affettionatiss.mo ser.re
Augustin Clusone Capitano del Artigliaria

Another independent source, Bernardo Tasso's *Amadigi* (Venezia, 1560), confirms the insight in the courtly hierarchies we have gained above. The author lets slip in his poem experiences made between 1557 and 1559, when he stayed at the Urbinate court with his son Torquato (cap. 100):

O quanti Cavalier, ch'l mondo bello
Fanno al lor valor, che seco adduce!
Ranier dal Monte, e Montin suo fratello
Io veggio appresso al glorioso Duce
Il conte d'Orcian Pier Bonarella
Ch'or ad Ancona dà splendore e luce
E quel di Montebello, e altri Conti
Tutti d'opere d'amore veloci e pronti.

Ranieri's central role at the court and closeness to the Duke is confirmed also some ten years later, by the report of the Venetian ambassador Lazzare Mocenigo (1570).[1] We come further to know that Ranieri was the General of the infantry of the troops of the Duchy of Urbino.

Vive Sua Eccellenza <Guidobaldo II> assai allegramente, dandosi piacere con li suoi gentiluomini; e quelli che sono continuamente appresso alla sua persona e pochissima parte del giorno si allontanano da lui, sono prima il Signor Pietro Bonarelli, il quale è sopramodo caro al Signor Duca et ha il titolo di Capitano generale della Cavalleria ed è quello che può ogni cosa presso Sua Eccellenza, con qualche risentimento del Principe <Francesco Maria>; poi il Conte Fabio Landriano,

[1] A more complete transcription of Mocenigo's report is exposed in Appendix II, I.1.

che ha una nipote del Duca per moglie, il Signor Rinieri del Monte, che è suo Capitano generale della Fanteria e il Conte di Montebello <Giovanni Stati>, che ha per moglie una sorella del Conte Pietro suddetto.

Around the year 1560, the Duke conceded Ranieri's son Guidobaldo his illegitimate daughter Felice della Rovere for his wife, which is another testimony of the excellent relation of the dal Monte family with the Duke.
Enlightening for the comprehension of Ranieri's relationship with the Duke is also his following letter.[1] He complains in it to the Duke in a surprisingly brisk way about outstanding payments connected with the marriage portion of Felice della Rovere. Only few subjects will have approached the Duke in a similar way.

Ill.mo et Ecc.mo S.re e P.ron mio sing.mo,
sono molt'anni che V.Ecc. Ill.ma si degnò dar per moglie la S.ra Felice a Guid'Ubaldo mio figliuolo, né, per molt'anni che sieno passati, gl'è stato mai fatto assegnamento alcuno di dote. E' ben vero che poc'anni sono, V. Ecc. Ill.ma si compiaccque che da Ugobbio gle ne fusse pagato il frutto. Nel pagamento del quale, per il poco conto che ne hanno fatto, i suoi ministri mi hanno [destratiato] sempre, come sanni i suoi segretari e tacendo io questo per minor fastidio di Lei.
Ultimamente essendo stati un anno che non mi hanno pagato, si son coperti col dire che ne sia stato causa l'assignamento del S.r Prencipe Ecc.mo et che per questo, per me, non ci sia stato modo alcuno da pagarmi; cosa che è falsissima perché l'assignamento del S.r Prencipe fu fatto circa quattr'anni sono e a me hanno satisfatto sempre eccetto quest'anno passato: et i ministri di quel tempo fanno fede che vi è modo da pagar il passato et il presente. Et se sia il vero o no, V. Ecc. Ill.mo lo considera da questo con la prudenza Sua, che l'assignamento di M.s Giovanni, che è stato d'assai dopo il mio, e pochi dì fanno quello del Cap. Valerio. Tutti sono stati pagati et io sono il patiente. Se si deve andar per chi sia anterior nell'assignamento, a me par che mi sia fatto torto. Et se'l si va per servitù, sa solo V. Ecc. Ill.ma se in me sia de' merito o no. Et si degni considerare che questi sono frutti di dote e non meriti di servitù. Tal che il tormi questo è un torre a me per dar ad altri.
Tutti questi errori mi vien detto che son causati al tempo del buon Girol<amo>. Il quale non può negare che non sii stato pregato di remedio, da me e le più volte da miei ministri, et sempre se ne è riso, facendone poco conto compiacendosi del mio pregiudizio, come sa m.s Giulio <Veterani> che ne ha avuto per mia cagione spesso molestia.

[1] Cf. ASF, Ducato di Urbino, I, 259, fol. 147r.

> Non restarò anco di dirLe, premendomi il caso come fa che il buon Pietro Pauolo Ondedei ha voluto ancor lui dar delle commissioni a suo modo, et valersi di questo assegnamento come gl'è parso. Se bene gli son stati mandati danari da Ugobbio, ad effetto che gli desse a me, et ne ha fatto il parer suo.
> Ora se questi tali sono incorsi in error alcuno a me par che ne doverebbono riportar gastigio. Et se questo gl'è stato commesso da altri, supplico V. Ecc. Ill.ma che si degni con la prudenza Sua dar qualche remedio a questo: non comportando che per commission d'altri mi sia tolto il mio.
> Altro non ho che dirLe: et umilmente Gli baso la mano, pregando il S.r Dio che Le doni quanto La desidera. Di Pesaro 3 di luglio 1572.
> Di V.Ill.ma Ecc.za
> Umil. E fid.mo ser.re
> Ranieri dei Mar.si del Monte

In effect, after the rather harsh tone in the precedent letter, Ranieri apologises to the Duke.[1] Apparently, he had reached what he had asked for.

> Ill.mo et ecc.mo S.re e P.ron mio sing.mo,
> io non speravo altro dalla bontà di V. Ecc. Ill.ma che quello che La si è degnata farmi sapere di aver comandato circa quel mio credito di Ugobbio, et umilmente Gle ne baso la mano.
> PregandoLa anco che si degni perdonarmi se io Le fussi parso più licenzioso che non dovevo nel esporGli il successo circa la tardanza che quei ministri hanno usato. Perché il bisogno mi ha forzato, respetto al poco modo che ho di remediar per altra via, alle provisioni che in questo tempo è necessario di far per la mia casa.
> Et come prima potrò non mancarò di venirmene al debito della mia servitù con lei, che ben so quanto son obbligato di obedir Lei, sopra tutte le cose di questo mondo, secondo che La mi comanda. Il che non posso far così di subito per quello che La intenderà da m.s Giulio <Veterani> che mi accade de impedimento che per minor fastidio Suo non lo scrivo a V. Ecc. E raccomandomi in Sua buona gratia, prego il S.r Dio che Le doni quanto La desidera. Di Pesaro VIIII luglio LXXII
> D. V. Ill.ma Ecc.za
> Umil. E fid.mo S.re Ranieri
> de Mar.si del Monte

Also after Guidobaldo II's death, Ranieri continued to be in the service of the new Duke, Francesco Maria II, as the next letters document.[2] This is a remarkable

[1] ASF, Ducato di Urbino, I, 259, fol. 148r.
[2] ASF, Ducato di Urbino, I, 259, fol. 149r.

fact, as most of the intimates of Guidobaldo II were persecuted and brought to justice by Francesco Maria II.

> Ogni volta che V. Ecc.za si degnarà di comandarmi per minima cosa che sia lo receverò sempre per favor grandissimo e La servirò con quella fedeltà e prontezza d'animo che ricerca l'obligo et la molta affettione mia verso V.E. Ill.ma.
> Si come non son mancato subito, veduto quanto La mi comanda, ordinar tutto quello che mi ha parso a proposito per onorare et ** questo S.r Card.le.
> E scrivendone più minutamente al S.r Giovani <Tommasi> di quanto si è fatto, non mi alungarò a dirLe altro per non fastidire V.E. Ill.ma alla quale prego il Sig.or Iddio che Le dia tutta quella felicità che Lei medema desidera. Et a me La prego che mi tenga in Sua bona gratia.
> Da Pesaro li XIIII di maggio 1575
> Di V.E. Ill.ma
> Oblig.mo serv.re Ranieri de'
> Marchesi del Monte

The next letter gives us an idea of the duties with which he was entrusted:[1] in the Duke's absence, he had to hand a letter over to a not explicitly named Cardinal who was staying at Fano.

> (...) Et caminando così quando si fu vicino al Ponte che si fa tuttavia sotto a Trebbiantico, per esser in quel luogo cativo passo, S.S. Ill.ma <il cardinale> smonto di carozza e mi prese per mano et andò così caminando a piedi sino alla Chiesa di Trebbiantico, e più oltre, e ragionando di molte cose, mi adimandò se V. Ecc. si dilettava della Caccia et io gli risposi che se ne dellettava assai, ma che si dellettava molto più d'altre cose, come giostrare, armeggiare et cavalcare, che in questo V. Ecc. Ill.ma si essercitava assai. Et che ogni cosa faceva tanto bene che non si potria desiderar più. Et che atendeva ancora grandemente alli suoi studii et che andava compartendo ordinariamente le sue ore in questi essercitii et alle volte a caccia. Ma con tutto ciò non lassava mai di dar odienza ogni dì al suo popolo et di espedir quanto occorrenva negli altri negotii che di tutto questo S.S. Ill.ma mostrò di restarne sodisfatta et che gli piacesse assai. (...)
> Et se in altro son bono a servir V. Ecc. La prego a favorirmi col comandarmi che non è cosa ch'io desideri più in questo mondo, che avere occasionene di poterLa servire con la vita, con i figli et con quel poco ch'io mi trovo. (...)
> Di Pesaro li 2 di settembre 1578

[1] ASF, Ducato di Urbino, I, 259, fols. 150r-151v.

I.3 Francesco Maria dal Monte

The present section exposes information about Guidobaldo's brother Francesco Maria. It does not intend to furnish (an even approximately) complete biography. Yet, it is advisable to keep in mind some aspects of his life and activity which contribute to a better understanding of Guidobaldo's biography. Our aim is, therefore, to highlight some elements of his *Vita* that seem particularly relevant for our purposes.

I.3.1 His early years in Rome

Around the year 1571, after his Paduan period, Francesco Maria dal Monte went to Rome and represented the interests of the Duke of Urbino in the environment of the Roman curia. He soon become one of the most important diplomats of the Urbinate court at Rome.
The following letter testifies Francesco Maria's involvement in the sale of the Duchy of Sora, owned by the della Rovere:[1]

> Ill.mo et Ecc.mo S. et P.ron mio Sing.re
> Doppoi ch'io Li scrissi altro non ho fatto che parlare con l'Albergati et gli diedi la lettera di V.E. il quale mi parlò con molta affettione, et fra l'altre cose alla prima mi affrontò a mezza lama, sopra questi benedetti presenti et mi fece un lungo raggionamento conforme a quello del Conte Ottaviano et perché ciò a lungo Gli scrissi non ne dirò altro.
> Questa sera è venuto il Papa et io mi fingo un poco indisposto et di già so<n> stato visitato et tenuto per tale; insomma con desidero aspetto lettere per poter subito esequire et tornare. Del resto mi rapporto a quanto scriverà il S. Amb.re et farò io fine umilmente, basciandoLi le mani. Di Roma li 21 di marzo del 1576
> Di V.E. Ill.ma
> Aff.mo et oblig.mo serv.re
> Fran.co Ma.a de' Marchesi del Monte

As the precedent letter, also the following[2] shows Francesco Maria's important diplomatic role. On the other side, he expressed his eagerness to "turn home". It seems as if, in his early Roman time, he considered his stay at Rome to be only temporary.

> Ill.mo et Ecc.mo S. et P.ron mio oss.mo
> Io ho fatto l'offitio con i sposi et so<n> stato tanto ben visto che ha superato l'espettatione assai ch'io mi ero imaginato. Il presente è stato mirato con occhio allegrissimo et è stato tenuto bello a fatto et

[1] Cf. ASF, Ducato di Urbino, Classe I, 126, fol. 796r.
[2] ASF, Ducato di Urbino, Classe I, 126, fol. 797r

credo che a quest'ora l'abbi forsi S.S.tà nelle mani.
Attendo a spedirmi a furia, et spero martedì o mercore al più lungo mettermi in viaggio et così in quattro giornatelle comparirò; né per ora avendo altro, fo fine umilmente basciandoLi le mani. Di Roma li 24 di marzo del 1576.
Di V. E. Ill.ma
Aff.mo et oblig.mo serv.re
Franc.co Mar.a de Marchesi del Monte

Yet, apparently the Duke had other plans with Francesco Maria dal Monte in Rome. The next letter[1] shows Francesco Maria's activity in another diplomatic task – in fact, in a not secondary one: the fact that he was chosen to negotiate with the ambassador of Spain let us intuit his position of high standing in the Duke's eyes and the ability he had proven in his antecedent negotiations.

Ill.mo et Ecc.mo S.r et P.ron mio sing.re
Questa mattina ho avuto la comissione di fare l'offitio con l'imbasciatore [sic!] di Spagna, et questa mattina l'ho fatto; et ha mostr<at>o averLa molto cara et che risponderà a V.E.
Feci l'offitio ancora col S.r Claudio, il quale scriverà l'animo suo a pieno a m.s Giulio Veterani. Se in altro vaglio, V.E. mi spenda poiché son seco. Et con questo faccio fine, basciandoLi le mani. Di Roma il primo di maggio del 1576.
D. V.E. Ill.ma
Oblig.mo et aff.mo serv.re
Fran.co Maria de' Marchesi del Monte

Another prove of the excellent relation between Duke Francesco Maria II and Francesco Maria dal Monte, who had grown together, is the following letter. The Duke of Urbino had apparently made his condolences to Guidobaldo's brother in occasion of their mother's death (on August 13th/14th), so Francesco Maria dal Monte replied:[2]

Ill.mo et Ecc.mo S.r et P.ron mio Sing.re
In questi miei travagli, grandissimo alleviamento mi è stata la lettera di V.E. poiché con tanta amorevolezza fa sì pietoso offitio verso un Suo aff.mo servitore et certo vedendo la memoria che V.E. per Sua bontà conserva di me mi so<n> tutto consolato; et con questa occasione lasciando le cose fastidiose con ogni affetto suplicoLa conservarmi per quel servitore che Ella sa ch'io Le sono, il che ottenendo come ne vedo in ogni occasione segni si amorevoli, vivrò sempre contentissimo et con l'umiltà basciandoLi le mani faccio fine. Di Roma li 25 di agosto del

[1] ASF, Ducato di Urbino, Classe I, 126, fol. 798r
[2] Cf. ASF, Ducato di Urbino, Classe I, 126, fol. 808r.

1576.
D. V.E. Ill.ma
Aff.mo et Oblig.mo serv.re
Fran.co Mar.a de' Marchesi del Monte

Also the letter written by Francesco Maria II della Rovere to Pietro Riccardi documents, in a considerable way, the excellent relations between the Duke and Francesco Maria dal Monte, as well as the diplomatic importance for the Urbinate court that Francesco Maria dal Monte had assumed in Rome and the high esteem in which he was held by the Duke already in 1576:[1]

> La sigurezza che abbiamo della amorevolezza dell'Abbate <Francesco Maria> del Monte verso noi è tale che ogni cosa che ci venghi detta intorno a questo, perché ne abbiamo creder di ciò parte maggiore, sarà sempre superfluo. Poiché ne crediamo la bastanza et la teniamo per fermissimo.
> Il S.re Ippolito <della Rovere> ci ha detto a nome dell'Abate medesimo si come avete scritto che vogliamo dire se incliniamo alla vendita dello Stato di Sora. Intanto a che gli abbaimo risposto si come è vero, di aver sempre sentito malvolentieri il venire alla alienatione di quello Stato come patrimonio. (...)

Only six years later, in 1582, Francesco Maria dal Monte had become a reliable and important figure in the Roman diplomatic *milieu*, acquainted with several cardinals, had further become the vice-legate of the Marche. His value for the Urbinate diplomacy may have grown considerably, not only because of Cardinal Giulio della Rovere's death in 1578.
The relations between Francesco Maria and the Duke were excellent as before: the former did not hesitate to declare his service and devotion "per infinita secula seculorum" – As the following paragraphs will illustrate, though, things were not meant to go this way.[2]

> Ill.mo et Ecc.mo S.r et P.ron mio sing.re
> L'E.V. mi favorisce di maniera che se io La volessi rengratiare come me Gli trovo obligato oltre che Gli verrei a festidio, non lo saprei nemeno fare; farò dunque di quelle mie belle ceremonie solite, con una bella riverenza basciarò le mani di V.E., specialmente con tutte le circonstanze che so<n> tenuto.
> Quel pochettino o niente ch io mi vaglia, mi piace che V.E. lo tenghi per cosa Sua come sempre serà tale per infinita secula seculorum et ho tanto desiderio che l'E.V. resti sodisfatta sì in questo come in ogni

[1] Cf. ASF, Ducato di Urbino, Cl. I, fol. 161, fol. 645; August 31st 1576.
[2] Cf. ASF, Ducato di Urbino, Classe I, 126, fol. 810r.

altro Suo pensiero che vorrei trasformarmi nella istessa sodisfattione acciò fosse tutta Sua, ma Lei è sì prudente che in ogni cosa so che l'otterrà. Né io per ora La noiarò più, ma facendo fine umilmente basaròlli le mani con una estrema gola del Barco di Casteldurante.
Di Roma li 10 di maggio del 1582.
D. V.E. Ill.ma
Oblig.mo et Aff.mo ser.re
Fran.co Ma.a de' Marchesi del Monte

In the meantime, Francesco Maria became also more familiar with the Cardinal de' Medici – his increasingly frequent nominations in the letters between Francesco Maria dal Monte and the Urbinate duke reflect this fact. For example, Francesco Maria had accompanied Ferdinando de' Medici during a journey to Florence in 1581.
In the course of the years, this acquaintance developed to a profound, reciprocal estimation, that rendered Francesco Maria one of Ferdinando de' Medici's most important intimates (cf. below). The following letter is a testimony of their collaboration, when Francesco Maria still was in the service of the Duke of Urbino.[1]

Ser.mo S.r et P.ron mio col.mo,
Avendo saputo di certissimo et dove si può sapere che al settembre N.S. leva i legati et muta tutti li governi, io vengo consigliato a non mi partire di Roma, massime fra un mese toccandomi a proporre; et se bene io non ricerco niente, et niente al sicuro mi serà dato, nondimeno per non mancare a me medemo, penso fermarmi qua acciò veda se almeno avranno tanta discretione di mandarmi a Fano o a Orvieto, poiché quando io serò fallito (col star qua) mi troverò nel capitale. Ora se a V.A. tornerà commodo se mi ** di me, sa che non può farmi gratia maggiore se ancora [sui] comanda che io venghi a servirLa, io mai mi partirò da Suoi comandamenti.
Di nuovo poi il Card. De' Medici credo che sia molto disgustato del Principe di Bisignano poiché S.E. nella liberatione di quel Paggio non si è fidato dell'opera del Cardinale et con mandare sotto mani altri in Spagna ha guast<at>o tutto il negotio. Il Re arrivò a Madrid et trattò da grande D. Gio di Zuniga et sopra tutti fece grandissime carezze a gran vela maggiori che mai l'abbi fatto, et andando al Scuriale solo ha alloggiato seco D. Pietro di Medici quale al più fra doi mesi serà in Italia.
Questo cavallerizzo de' Re di Francia mio finalmente con il mezzo di Medici ha ottenuto licenza da V. Re di cavare 18 cavalli di regno. Il caso di questi romani lo lascio al Falcucci, et a V.A. baso le mani. Di

[1] ASF, Ducato di Urbino, Classe I, 126, fols. 824r-825r.

Roma li 27 di aprile del 1583.
D. V.A. Ser.ma
Aff.mo et obl.mo serv.re
Frano M.a de' Marchesi del Monte

I.3.2 Francesco Maria's refusal of the mitre of Pesaro in 1586: a decision between the Della Rovere and the De' Medici

Yet, Francesco Maria's rise did not remain without critical moments and decisions. Probably the turning point of his entire career was the year 1586: in occasion of the bishop of Pesaro's death, the Duke of Urbino had had the intention to make him the new bishop of Pesaro – probably for gratitude for the services of the dal Monte family in general, and in particular of Francesco Maria at Rome. The circumstances are not entirely cleared, but Francesco Maria seems to have shown disinterest towards the task. This gesture caused, comprehensively, the Duke's annoyance. The following serious of letters gives an idea of Francesco Maria's behaviour and the Duke's reaction
This *affaire* is relevant also for the comprehension of Guidobaldo's biography: it was probably the first occasion for tensions between the dal Monte family and the Duke of Urbino. The deterioration of these relation had tragic consequences for the Marchigian mathematician.
Initially, Francesco Maria dal Monte seems to have intended, even if reluctantly, to accept the office as bishop of Pesaro, which is testified by the following letter.[1]

> Se bene io non ho mai avuto umore a vescovadi come V.A. sa, nondimeno per obedire a N.S. <il Papa> e ricevere il favore che mi fa V.A. l'ho accettato et bascio le mani di V.A. del favore che mi ha fatto, sperando con fatti di pagare in qualche parte tanti oblighi che Le tengo (...).

Yet, the following letter shows Francesco Maria as little enthusiastic about the nomination. At the same time, it testifies the intervention of the Cardinal de' Medici from the very beginning of the *affair*.[2]

> Ser.mo S.r et P.ron mio col.mo
> Per la brevità del tempo non potei dar conto a V.A. come era passato il negotio del vescovado; ora Le dico che N.S. <il Papa> restò con <il

[1] Cf. ASF, Ducato di Urbino, Cl. I, fol. 137, fol. 373; February 15th 1586; this extract is reported also in Z. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, cit., pp. 48/49, note 33.
[2] Cf. ASF, Ducato di Urbino, Classe I, 126, fol. 852r.

Cardinale de'> Medici di darmi detta Chiesa, ma che vuole mettervi sopra ducento ducati di cammera per un suo serv.re del che ne ho raggionato a lungo con l'agente Suo, al quale riportandomi; e in questi giorni santi non Le darò altro fasctidio, ma farò fine con basciarLi le mandi. Di Roma li 2 di aprile del 1586.
Di V.A. Ser.ma
Devotiss.o serv.re
Fran.o M.a dal Monte

Francesco Maria's hesitation seems to have being caused also by financial questions, as the following letter reveals. It is remarkable, yet, how openly he shows that being bishop of Pesaro would have meant for him rather an unwelcome duty to fulfil than an honour or a favour, when he said "without doubt it will put the yoke on my neg in order to serve you".[1]

Ser.mo S.r et P.ron mio col.mo
Vedendomi io entrare in molte spese, debbiti et pesi importantissimi, trattai con il S.r Gratioso liberamente tutto il progresso del negotio del vescovado, acciò con il favore di V.A. mi potessi sotrare da questi pesi, confidatomi nella sollita Sua benignita cerso me. Ma avendo con alcuni patroni miei conferito il medemo, vedendo il negotio inchiodato, mi dissero che era cosa vana trattare d'innovare cosa alcuna poiché piutosto avrei sdegnato N.S. et forsi con maggior mio danno che moverlo di quanto ha determinato di fare il che subbito feci intendere al sodetto S. Gratioso.
Ora avendo intesto quanto V.A. scrive dico che senz'altro metterò il collo al giogo per servirLa, restando perpetuamente obligatissimo alla buona volontà che V.A. in ogni occasione sempre mi ha dimostrato, et particolarmente in questo vescovado.
Giovedì mattina N.S. commise al S. Card. De' Medici che al primo concistoro mi preconizasse et se bene S.S. M.ma pregò S.S.tà a farmi questa gratia nondimeno in ogni maniera volse che lo facesse S.S. Ill.ma. Con che facendo fine a V.A. umilmente baso le mani. Di Roma li 12 di Aprile del 1586
D. V.A. Ser.ma
Aff.mo serv.re vero
Fran.o m.a dal Monte

In fact, he himself must have become aware of his unappropriated answer, so he wrote another letter in the following terms to the Duke:[2]

Ser.mo S.r et P.ron mio col.mo
Dalla cortesissima lettera di V.A. ho conosciuto quello che in ogni

[1] Cf. ASF, Ducato di Urbino, Classe I, 126, fol. 853r.
[2] ASF, Ducato di Urbino, Classe I, 126, fol. 854r

occasione ho sempre visto della amorevolezza Sua verso di me, di che non so che altro me Le dire se non che Gli sono quel servitore di sempre et serò. Questo negotio ha visto un poco di fredezza in me, e poceduto [sic!] tutto dal peso che mi soprastà adosso, ora che la cosa è conclusa, vedrà con quanta caldezza io sarò a servirLa, et mi par mill'anni di essere alla chiesa per servirLa. Di già mi son messo *in sacris*, et attendo quanto più posso a sbrigarmi dove dagl'effetti conoscerà la mia devotione et umilmente Le baso le mani. Di Roma li 23 di aprile del 1586.
D. V.A. Ser.ma
Devotiss.o et aff.mo serv.re
Frn.o M.a dal Monte

Francesco Maria's ordination as bishop seems to have been practically decided. Yet, the following letter testifies a dramatical turn of the events:[1]

Ser.mo S.r et P.ron mio col.mo
L' esclusione del vescovado di Pesaro mi ha dato infinito travaglio, temendo che senza mia colpa avessi a perdere la gratia di N.S. overo quella di V.A. Ora avendomi S.S.tà messo in consulta con le sue sollite bonissime parole ciò mi ha assicurato della gratia di S. B.ne. Circa poi a quella di V.A. che non punto meno estimo, anzi la reputo al pari della vita mia istessa, non potevo credere di perderla in modo alcuno sì per le infinite dimostrationi cominciate dal S.r Duca Suo Padre di fel. m. et continuate sino al presente giorno con tutta casa mia, et particolarmente con me, poiché ho tocc<at>o con mano che, da che nacque V.A., mai ha tralasciato occasione di favorirmi; ora sarei pazzo a fatto se credessi che in un punto si fosse mutata, et senza causa alcuna.
Ma avendomi il S.r Gratioso acennato come è passato il negotio son restato consolatissimo assicurando V.A. che questo mi è il maggior contento che possi desiderare in questo mondo et che quel servitroe che Le nacqui, quello istesso Le voglio morire et in tale proposito son stato et starà sempre come il Gratioso, questa corte et per tutto dove ho praticato me ne faranno sempre fede. Tengami tale V.A. che mi farà vivere sempre contentissimo et umilmente Le baso le mani. Di Roma l'ultimo di aprile del 1586.
Di V.A. Ser.ma
Oblig.mo et Devotiss.o serv.re
Fran.o M.a dal Monte

In effect, even if the precedent letter suggested that the Duke of Urbino had not been annoyed because of Francesco Maria's disinterest, the following one from

[1] ASF, Ducato di Urbino, Classe I, 126, fol. 864r/v.

Ranieri dal Monte to Giulio Giordani is a prove of the contrary. The sorrow of the head of the dal Monte family is clearly perceptible in the letter, and he tried to use his still unbroken influence at the court to limit the damage for his house.[1]

> Molto Mag.co Sig.r mio hon.do
> E' tanto il travaglio che mi aporta il fine che han auto le cose di questo benedetto vescovato, con tanta mala sodisfattione de' padroni che non so qual'altra cosa mi avesse potuto apportare il maggiore; che utramente non me ne posso quietare, che di tutto ne sia lodato il Sig.r Dio al voler del quale ci dobbiamo sempre riportar volentieri.
> Con tutto ciò, non ho voluto restare di mandar questa lettera qui alligata[2] che recevei ier' sera dell'abbate <Francesco Maria dal Monte> se bene è un poco vechia. La quale piacerà a V.S. mostrarla al Sig.r Giulio <Veterani>, e Le piacerà anco, avendosi inteso alt.o di più di farmene un poco di parte a me ancora, che me ne farà V.S. et il Sig.r Giulio piacer e favor grandissimo. Et con offerrirmi al'uno e l'altro con tutto il core, e pregandoLi acomandarmi me Le raccomando che Dio Gli contenti. Di Monte Baroccio il primo di maggio 1586
> Di V.S.
> Come fratello a.le
> Ranieri de' Marchesi dal Monte
> <P.S.> Sarà qui alligato una lettera che il detto Abbate scrive a S.A. che piacerà a V.S. di farla dare quanto prima.

Apparently, Ranieri dal Monte had succeeded in placate the situation:[3]

> Ser.mo Sig.r e Patron mio Col.mo
> E' stato tanto il travaglio che ho patito nell'animo a questi dì passati, dopoi ch'io intesi dalla lettera di V.A. e dal Sig.r Giordano, mandato qua da Lei nel termine che si trovavano le cose del vescovato che non so veramente qual mi avesse potuto sucedere maggiore e quello che mi travagliava più d'ogni altra cosa, era che temeva grandemente che l'A.V. non avesse preso di ciò qualche mala sodisfattione della quale facevo più stima che di quanti vescovati sono al mondo e di qual si voglia altra cosa, che potesse esser di onore e di comodo al detto abbate <Francesco Maria dal Monte>.
> Ma poi che vedo ora chiaramente nell'amore<vo>liss.a lettera di V.A. che in Lei non resta mala sodisfattione alcuna di esso abbate, et che più presto mostra aver sentito dispiacere insieme con noi altri che questo negotio non abbi a<v>uto quel bon effetto che si desiderava

[1] Cf. BOP, ms 412 fol. 8r/v.
[2] There is, though, not left any trace about this attachment.
[3] Cf. ASF, Ducato di Urbino, I, 259, fol. 161r.

per il comodo che portava questo vescovato alla casa nostra e per il desiderio che teneva l'A.V. di veder qua l'abbate con occasione tanto onorata che questo insieme con la bona volontà che mostra più che mai, di tener verso tutti noi, mi ha tanto quietato et consolato tanto, quanto poteva desiderar io medesimo: poiché nel resto piglio ogni cosa dal voler di Dio Benedetto, et assicuro l'A.V. che quanto piacerà a Sua D.a Maestà di concedere al detto abbate che come la dice Lei, il luogo che gli ha dato S.S.tà nella consulta, potrà esser scala a gradi maggiori che quali si saranno che sia sempre quello piace a Dio, lui et noi altri tutti gli saremo sempre mentre ci durarà la vita.
Et quanti ne verrà di noi quei obligati servitori che Le siamo stati sempre et più se più si può dire, poiché più che mai si vede la bona volontà che La si compiace per benignità Sua tener verso noi. Et io non potendo adesso farLe altra dimostrazione dell'animo mio, restarò pregando l'A.V. che si degni comandarmi e tenermi vivo nella bona gratia Sua, et con farLe umil riverenza, Le bascio le mani et Le prego dal Sig.r Dio ogni desiderata felicità. Di Monte Baroccio li 7 di maggio 1586.
Di V.A. Ser.ma
Devot.mo et oblig.mo Ser.re Ranieri de'
Marchesi del Monte

Shortly afterwards, as the new Bishop of Pesaro is nominated instead Cesare Benedetti (1540-1609). Giov. Batt. Almerici, coeval local historian writes in this regard:[1]

1586 3 maggio: essendo morto il dì 8 febbraro 1586 di sabbato a sei ore di notte Mons. Roberto Sassatelli vescovo di Pesaro e sepolto in duomo a due ore la domenica sera sotto il giorno, predetto Mons. Cesare Benedetti fu fatto vescovo della sua patria, come dalle bolle, e dì 27 giugno prese possesso del vescovado."

As the next letter from Guidobaldo's brother to Giulio Giordani testifies, the *affair* continued to be present in the epistolary exchanges between Francesco Maria dal Monte and the Duke's secretary; further, also the involvement of Cardinal de' Medici is documented: presumably, Francesco Maria dal Monte's orientation towards the service for Ferdinando de' Medici was the real reason for his rejection of the office as bishop of Pesaro.[2]

Molto Mag.co S.r mio oss.mo
Avendo io scritto a S.A. sopra quei particolari che V.S. sa, et non avendo inteso altro dopo il suo arrivo, ne sto con molto martello,

[1] Cf. BOP, ms 455, fols. 327v-328r (Spogli dell'Almerici)
[2] Cf. BOP, ms 426, fol. 95r/v; June 3rd 1586.

non essendo men geloso della gratia del S.r Duca che dell'istessa vita mia; per tanto favoriscami V.S. di un verso, avisandomi come sono interpretate le mie parole che invero se io potessi mostrar il core, non occorrerebbe che io mi affaticassi in altro.
Con il parere del S.r Oratioso ho fatto una passata con il S.r Cardinale de' Medici sopra il ragionamento che V.S. ebbe ultimamente seco; il quale mi ha detto che fu colto tanto all'improviso da Lei sopra quel particolare che rispose confusamente et si dolse meco che io non gli avevo fatto saper prima cosa alcune che avrebbe forse sodisfatto più [sé] et il S.r Duca et che non si ricorda pure quello che dicesse poiché pensava che V.S. gli parlasse piutosto d'ogn'altra cosa che di questa. AvendoLi detto che tutto è proceduto dal desiderio che ha S.A. che S.S. Ill.ma resti [capace] del negotio come è passato, hammi risposto che crede tutto quello che già dissi lungamente a V.S. a bocca et di più mi ha soggiunto che dal S. Duca ha sempre ricevuto gratie et favori et che altro non desidera che servirlo, con molte altre parole simili piene di amorevolezza et affetto. Sì ché, S.r Giulio mio, se una mezza parolina prima V.S. mi diceva restava sodisfattissima. Ora io l'assicuro che se il Cardinale avrà occasione servirà con ogni affetto il S.r Duca, glelo scrivo acciò V.S. procuri che il S.r Duca le commandi che troverà dagl'effetti verissime le mie parole. //
La prego poi a scrivermi un verso se vi resta scrupulo alcuno de' fatti miei, poiché son rissolutissimo che il S. Duca et il mondo sappino che io sono quel di sempre. Et senza rileggere questa mia faccio fine, basandoVi la mano. Di Roma li 3 di giugno del 1586.
D. V.S. S.re Fran.o M.a dal Monte

Giulio Giordano answered to Francesco Maria:[1]

Molto Ill.re et Rever.mo Sig.r mio Oss.mo
Ho conosciuto la lettera di V.S. così piena di tutto quel ch'io potevo immaginarmi che fosse per piacer' al Sig.r Duca, sì per quello che tocca a Lei, com'anco per quello ch'appartiene a Mon.re Ill.mo de' Medici, che m'è parso bene di farla vedere, sì com'ha fatto all'Altezza sua propria, la quale ha mostrato di vederla molto volentieri, perché il riporto fatto da me di quanto avevo trattato l'ultima volta col Sig.r Card.e l'aveva fatta restare non poco sospesa, parendo le dalla risposta che non si fosse ben capita l'intention sua, la quale fu solo di scoprire se nell'animo di S.S.Ill.ma restava niun'ombra della sincerità et nettezza del Sig.r Duca, il che molto le premeva non solamente per il torto ch'alla professione che fa le pareva di ricevere, ma anco per il dubbio c'aveva [INTERL: che da qualcuno] si cercasse, o per

[1]Cf. BCF, Collezione Piancastelli, Carte Romagna 125/145, June 9th 1586.

dir meglio, si continovasse di cercare di levar via quell'amore che con tanto desiderio avea procurato che fosse tra esso et il Sig.r Card.e, et anco col Granduca. Et però era parso bene con quel [tema] dato da me per commissione di S.A. al Sig.r Card.le di accertarsi se vi restava sospetto alcuno, risoluta poi (conoscendolo) di far in modo che S.S. Ill.ma et ogn'altro restassero ben chiari, ch'in Lei mai era stato in questo negotio (com'anco in niun altro) doppiezza alcuna, sì che assai L'è piaciuto di vedere che il Sig. Card.e conosca in Lei quello di che proffessa sopra ogni altra cosa, perché in vero si come grandemente desidera di continovar et accrescere la servitù et amicizia c'ha seco et con casa sua, così quando dal Sig.r Card.e non fosse l'Altezza sua tenuta per quella che è, malamente potrebbe ciò fare, ancora che questa // conservazione di benevolenza sia, com'ho detto, uno dei principali desideri ch'Ell'abbia, anzi esser in Lei desiderio d'accrescerla quanto più possibil sia, quando vegga ch'in ciò Le sia corrisposto in altro che in parole di creanza.

Quanto a V.S. ha poi detto non aver potuto fare di non dolersi ch'Ell'abbia sospettato cosa di S.A. della quale niuno può né deve ragionevolmente sospettare, di che però non vuole altra vendetta o satisfattione di quella che sa d'avere, essendo certa non poter essere che V.S. non senta rimorso nell'animo suo et che non senta anco molto dispiacere che sia nato tanto rumore, per aver voluto far bene a Lei et a casa Sua del quale ancorché Ella non avesse bisogno, pure non poter negarsi che l'intention sua non sia stata buona. Ha poi soggiunto non aver risposto alla lettera di V.S. portata da me perché desiderava [sopire] questa facenda, essendo risoluta di voler sodisfarsi della conscienza sua sapend'anco che chi se ne voleva chiarire aveva la via molto facile di poterlo fare, et però quanto meno si trattava di questo, più Le piaceva, credendo dall'altro canto che V.S. non averebbe di far ciò ch'i benfiti ricevuti dalla casa Sua meritavano.

Questo è stato tutto quello ch'il Sig. Duca ha detto sopra la lettera di V.S. il che m'è parso bene di riferirle puntualmente, non alterando punto la sustanza né pur le parole istessse, perché credo che ciò sia per piacere grandemente a Lei et a Monsig.r Ill.no de' Medici, per vedere con quanta sincerità e schiettezza si desidera da questo Principe la gratia e benevolenza di S.S. Ill.ma. Circa il part.re di V.S. poi Le dico che La può star sicura che nell'Altezza sua non resta altro nel pensiero intorno a questo negozio passato, se non quello c'ho già detto, però come servitore che Le sono l'essorto e prego a continovar di procurare che si mantenghi la buona intelligenza et amore fra questi Sig.ri et case loro, anzi che s'accresca come so' certo che facilmente succederà se di là s'avrà la corrispondenza che si conviene, et Le bacio la mano pregandoLe da Dio ogni contento e felicità. Di Pesaro li VIIII Giugno

1586
Di V.M. Ill.re et Rever.ma
Serv.e Aff.mo
Giulio Giordano

I.3.3 The nomination as Cardinal in 1588

In 1587, the Grand Duke of Tuscany Francesco I died. His brother, the Cardinal de' Medici, consequently renounced to continue to be cardinal and became his successor as Ferdinando I. Francesco Maria dal Monte's extremely high standing in the environment of the fresh crowned Grand Duke can be deduced from the following document, written by an ambassador of the Venetian Republic, Tommaso Contarini:[1]

> (...) <Ferdinando de' Medici> mangia sempre ritirato, né ammette alcuno alla sua tavola, né che sia presente al suo mangiare all'infuori di Monsignor Del Monte, che è partecipe di tutti suoi più secreti pensieri, e il quale, non si discostando mai della persona del principe, anco a tavola gli fa compagnia (...).
> Ha appresso di sé il granduca altre persone con el quali tratta confidentemente e famigliarmente, e, essendo assidui alla sua persona, secondo l'occasione e con qualche parola, possono giovare o nuocere assai alli negozi. Monsignor abate Dal Monte si è introdotto, già molti anni, nella grazie di Sua Altezza, ed è stato così indefesso al suo servizio che né alla campagna, né alla città, né per alcun accidente, mentre era in Roma, abbandonava mai la sua persona. Onde essendo fatto consapevole di tutti li suoi desideri, gli è molto caro e lo tiene appresso di sé sempre ed in ogni luogo. Ha <il Dal Monte> cognizione di lettere e di diverse cose, è cupidissimo della grazia del granduca, e s'invaghisce assai d'essergli così intimo e famigliare, consolandosi che sia così favorito; ed all'incontro Sua Altezza l'ama ed ha piacere che sia laudato e stimato; perciò gli ha dato beni di Chiesa e collocata in lui ogni grandezza ecclesiastica (...).

With Ferdinando de' Medici's coronation as Grand Duke, the Tuscan State had lost his main diplomatic character at the Roman Curia.
As successor for the representation of the Medici interests was chosen exactly Francesco Maria dal Monte. On December 14th 1588, he was made cardinal by the pro-Medici Pope Sixtus V. On the same day, the former wrote to his patron Ferdinando de' Medici:[2]

[1] Cf. A. Segarizzi (ed.), *Relazioni degli Ambasciatori veneti al Senato*, vol. IV, Bari, Laterza, 1916.

[2] Cf. Z. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, p.111; ASF, Mediceo 3755 cc. nn.

(...) Finalmente l'A.V. S.ma mi ha fatto questa mattina promovere al Cardinalato da S.S.tà, et si come in questa attione V.A. S.ma viene celebrata per uno esempio di Principe grande, di autorità, di costante, et di benefattore, e liberale co' suoi servitori; così io mi sforzerò di mostrarmi un esempio di gratitudine, per quanto potranno mai le forze mie, poiché posso ben dire di esser fatto cardinale, beneficiato, provisto et adobato da V.A. S.ma one per ora non cesso, né cessarò mai di pregare il S. Iddio che La prosperi et feliciti secondo gl'affettuosi prieghi miei, sintanto che La piacerà di impiegarmi in casa di Suo servitio.

Consequently, Francesco Maria dal Monte became, besides Cardinal Montalto, the most important cardinal on the side of the Medici "party".[1] Very helpful to comprehend Francesco Maria's close relation to Grand Duke Ferdinando I is the following list, composed by the Florentine administration, concerning the guests received by the Grand Duke. The Cardinal appears regularly as guest of the Grand Duke himself, ate even "at his table", often over several months. The list is interesting also for its information on other member of the dal Monte family, like Guidobaldo, Orazio and Carlo dal Monte.[2]

[p. 25] Prima classe di forestieri venuti dopo le nozze 1589:
(...) Sig.r Guido Baldo dal Monte arrivò in Livorno alli 12 di gennaro, fu alloggiato in fortezza, servito in argento da staffieri, con un piatto di sua tavolo, 4 bocche in tinello e 5 cavalli alle stalle; e partì il dì 9 de febraro con una nostra lettigha.
(...) [p. 34] Mon.s Ill.mo Card.le dal Monte arrivò in Fiorenza alli 9 di luglio 1591 e visse alla tavola di S.A. et in camera si sono spesati 2 sua gentiluomini et una servitore sino alli 7 di ottobre che partì per Roma.
(...) [p. 41] Sig. Carlo dal Monte mandato dal S.r Marchese del Vasto arrivò in Prattolino, si alloggiò alle stanza terrene; l'intertenne il S.r Oratio suo fratello pagio di S.A. e vi fece 3 piatti servito dal Mariozi con un piatto di sua tavola.[3]
(...) [p. 48] Mons.r Ill.mo Card.le del Monte arrivò in Firenze alli 2 d'ottobre <1593>, si alloggiò ne Pitti sul salone della capella servito

[1] Cf. Waźbiński, *Il Cardinale Francesco Maria del Monte 1549-1626*, p. 122: "il cardinale Montalto (..) <e> il Dal Monte, i due maggiori fautori del partito toscano nel Sacro Collegio."

[2] Cf. ASF, Guardaroba medicea Diari di etichetta, 1. The respective page numbers are inserted directly in the transcription.

[3] This item does not contain any data. Since, however, practically all items in this document are ordered chronologically, we can deduce with all probability the date do be the beginning of August 1592: The item before reads "Sig.r Residente di Venetia il dì 31 di Luglio venne da S.A. in Pratolino e vi desinò servito dal S.r Mariozi secondo il solito." And the entry afterwards is "Sig.r Conte Ercole Gonzaga desinò a Pratolino il dì 12 d'agosto servito con un piatto come sopra."

dal S. Vincentio Guigni, visse per lo più alla tavola del Gran Duca. Due suoi al tavolino, un servitore in tinello, un cavallo alla stalle: partì alli 25 d.o con una caroza di S.A. e quattro bestie di vettura a nostre spese.
(...) [pp. 49/50] Sig. Gio. Battista del Monte Generale di Venetiani arrivò al Poggio da S.A. il dì 16 di settembre, li fece un piatto per lui et un piatto per 6 suoi. Quattro bocche in tinello e 6 cavalli alle stalle. // Vi stette sin'alli 18 e venne con S.A. all'Ambrogiana e quivi si spesò da noi in casa del Camillo suo fratello e nel Poggio fu servito da Gio. Perozi con staff.re.
(...) [p. 54] Mons. Ill.mo Card.le dal Monte arrivò in Firenze alli 17 di Luglio <1594>, si alloggiò ne Pitti, visse alla tavola di S.A. con due gentiluomini al tavolino, tre servitori in tinello et un cavallo alle stalle. Partì per Roma con nostra lettiga alli 18 d'ottobre dall'Ambrogiana.
(...) [p. 58] Sig.r Filosofo Mazzoni; Quando viene alla corte si spesa in camera e due servitori in tinello.[1]
(...) [p. 59] Mons. Ill.mo Card.le dal Monte arrivò in Fiorenza al 3 di ottobre <1595> e s'alloggia e serve conforme al solito. Partì alli 16 di novembre con una nostra lettiga e due muli di soma per a Roma.
(...) [p. 67] A dì 8 di Marzo <1596> l'Ill.mo et Ecc.mo Sig.r Duca di Lussembourg imbasc.re del Re Christianissimo a sua B.ne venuto da Genova con una galera della Sig.ria arrivò a Pietra Santa et stante il Gran Duca a Livorno, mandò a Pisa a incontrarlo al Serchio con carozze il S.r Oratio de' Marchesi dal Monte Castellario e Governatore dell'Arme a Pisa et arrivati in Pisa trovorno alla porta gran numero di carozze e gentiluomini pisani et di corte che lo accompagnorno al palazzo e la gente nobile con seco e la più bassa all'osteria per scarsità di stanze. (...)
(...) [p. 89] A dì 25 di luglio 1598 L'Illustrissimo e R.mo Cardinale dal Monte questo dì venendo di Bologna con una nostra lettiga desinò in Pratolino dove è il principe e la sera venne a Firenze ricevuto dal Gran Duca alle stalle et alloggiato ne Pitti alle 4 camere e salotto della cappella servito dal Sig. Cav. Portasanella e intertenuto dal S.r Emilio de' Cavalieri. Il Card.le mangia sempre con il Gran Duca: il suo segretario m.s Francesco Lucchi al tavolino col suo prete: partì al dì 25 di agosto. In tinello un piatto per il capellano e 3 di camera e tutti partirno. In tinello numero sei staffieri e cocchieri restorno numero 3 a dì 25 d'agosto che li altri partirno; alla estalle una chinea, una mula e sei cavalli in tutt, numero 8 partirno al 25 d'agosto.
Partì il dì 30 di gennaio '98 con una delle nsotre lettighe e se li detti cena a Poggibonzi mediante l'esserci quivi la casa che aveva spesato

[1]The date can be deduce by the preceding and following items: it was June 1595.

la medesima mattina a desinare il Card.le Montalto.
(...) [p. 137] A dì 6 di luglio 1602. L'Ill.mo Card.le dal Monte è venuto a Artennino dove è tutta la corte con un segretario, un cameriere e due staff.ri e si è alloggiato in palazzo sul piano del Gran Duca e magnia con loro Al.ze. E due sua al tavolino, e due in tinello. Partì a dì 11 di dicembre 1602 per alla volta di Roma e se li dette per insino a Roma la seconda lettiga che mena Sandrino con un cestino di robe da magniare per la sua desinata.

Interesting is the following description of Francesco Maria dal Monte, made by Cardinal d'Este in 1599 in the context of a report about Pope Clement VIII's court:[1]

Fran.co Maria Car.le del Monte
Fu cortegiano già di Sforza il vecchio, e per una sua maniera affabile e graziosa entrò talmente in gratia al Car.le di Medici che fatto Gran Duca l'impetrò il Capp.o che lasciava. E' di Marchesi del Monte S.ta Maria che si fanno della Casa Borbona; e ne portano l'insegna; era conf.mo del Duca d'Urbino del quale portava l'armi inquartate, ma dopo che si concesse al Gran Duca non troppo con fid.te d.[o] Urbino diede tal disgusto a questo Principe massimamente quando levò delle sue l'armi della Rovere che non bastò l'interessamento di m.[ti] Car.li a riconciliarlo seco. Per la sua maniera piacevole s'è reso grato al Papa, et ad Ald.no, quantunque come seguace del Gran Duca egli non fosse delle fautori della creazione di S.S.tà. E' di ibelle lettere et insomma è tutto dipe<n>dente dal Gran Duca; ha da e[nco].m[io] scudi d'entrata 3 mila d'una abbadia in Padova, che ebbe già del Gran Duca, melle de' pensione da questo Papa sopra l'abbadia di S. Galgano di Siena e 3 mila in alcune altre // picciole abbadie oltre quello che il Gran Duca li somministra secondo il bisogno. Del S.r Guidobaldo del Monte suo fratello: è gran matematico, ha parenti, nepoti, ma niun appresso di sé.

Francesco Maria's continued to assume an outstanding role as *nexus* between the Florentine court and the Roman *Curia*, also many years after his nomination as cardinal: this emerges *inter alia* from the following document, written in occasion of the Medici Leo XI's election as Pope:[2]

Ser.mo S.r et P.ron mio Col.mo
Questa sera a due ore di notte abbiamo fatto Papa il Card.le di Fiorenza et si chiama Leone XI. Mi ha detto che vuole che io sia il mediatore

[1] Cf. ASF, Carte strozziane, prima serie, 226, fol. 156r/v.
[2] Cf. ASF, Mediceo del Principato, 3761; the folios in the folder are unnumbered, despite of the fact that it contains more than 500 folios.

tra V.A. et lui, et che tratti le cose sue et mi disse queste formali parole "Io Vi metto in mano la più cara cosa che abbi in questo mondo che è il Gran Duca, la moglie et li suoi figluoli."
Et dà molta sodisfattione a tutti et Le bacio le mani. Di Roma il primo di Aprile a 4 ore di notte del 1604.
Di V.A. Ser.ma
Obl.mo Ser.re Vero
Il Card.le dal Monte

I.3.4 Aspirant for the Holy See

The influence of Cardinal dal Monte in the curia was remarkable: as the following description of the conclave of 1623 testifies, he was among the "*papabili*"; cf. the entry "Monti":[1]

[fol. 218r/v] "1623 Discorso del presente Conclave"
Borghese ha con lui 23 voti per far l'esclusione, cioè Borthese, Barberino, Mellino, Verallo, Leni, Rivarola, Crescenzio, Monte, Careffa Ascoli Trescio, Savelli, Prioli, Valerio, Bentivogli, Roma, Campora, Cennino, Gherardo, Scaglia, Pignattello, Bevilacqua. Arà per far l'inclusione voti 13 cioè Borghese, Leni, Rivarola, Muti, Serra, Savelli, Prioli, Valerio, Bentivogli, Roma, Trescio, Gherardi, Pignatelli, e vi s'aggiungono le creature papabili che aranno perduto la speranza.
Lodonisio et Aldobrandino aranno con loro per far l'esclusione voti 20, cioè Sauli, Monti, Barberino, Deti, Peretti, Ginnasio, Pio, Ridolfi, Torres, Fozzadino, Buoncompagno, S.Susanna, Gaetano, Sacrati, Ghiselli, Ubaldino, Capponi, Aldobrandino. Aranno per far l'inclusione voti 11, cioè Lodovisio Aldobrandino, Torres, Buoncompagno, Gozzadino, Ridolfi, Ghiselli, Ubaldini, Capponi, Deti, e Pio, e vi s'aggiungono li papabili che saranno fuori di speranza.
Li spagnoli entrono in conclave con voti 15, cioè Sforza, Madruzzo, Farnese, Doria, Caraffa, Savelli, Borgia, Trescio, Medici, Zelleri, Gaetano, S. Severino, Torres, Ridolfi et Este.
Li francesci hanno 6 voti cioè Savoia, Bentivoglio, Pio, Ubaldino, S. Susanna, Bevilacqua.
Li fiorentini aranno voti undici cioè Monti, Sauli, Bandino, Peretti, Medici, Barberino, Capponi, Ubaldino, S. Susanna, Bentivogli, Ridolfi.
Li spirituali son otto cioè Buonromeo, Sante, Araceli, S. Susanna, Zolleri, S. Severino, Sderati e Caraffa. Vecchi pretendenti che passono

[1] Cf. ASF, Carte Strozziane, prima serie, 226. The respective folios are indicated directly in the transcription.

50 anni sono Sauli, Monti, Barberino, Buonromei, Bardino, Ginnasio, Sforza, Bevilacqua, Madrucci, Mellino, Veralli, Sante, Araceli, Ascoli, S. Susanna, Campera, Cennino, Scaglia, Caragga, Gaetano, Sacrati, S. Severino. Sauli ha l'antica opposizione di Monfrone, evi sono ancora le reliquie delle // escludenti Aldobrandini e Borthesani, né se ne fidono. L'aldobrandini, spagnuoli e francesi non l'aborriscono, li fiorentini lo portano ma la descrepità più d'ogni altra cosa, con questa bolla l'aiuta.

Monti è stimato troppo fiorentino e francese, non spiace a spagnioli né anco a borghesini; nel passato conclave li fiorentini lo portorno insieme con li francesi; la vechezza l'aiuta e dalli Aldobrandini non è refiutato.

Sforza è più soldato di prete.

Bandino viene escluso da Borghesani e da una parte de' fiorentini, i spagnoli non se ne fidono, gli da danno la moltitudine de' nepoti, e portato dalli Aldobrandini e lodovisiani, e non è refutato da francesi; è conosciuto per cardinale di gran sapere e virtù e che meriti il Papato.

Buorromei è stimato troppo zelante, nemico de' frati, amatore delle riforme. Escluso da' spagnoli, temuto da' Borghesiani. Portato da Aldobrandini e Lodovisiani, accetto a francesi e da alcuni altri desiderato per bontà di vita.

Ginnasio è tenuto stretto di natura assai austera, ancor che la vadi a nascondere. Non accetto a' Borthesani, se ben Borghese non l'esclude, non è refutato da' Spagnoli né da Fiorentini, né da Francesi. Et è portato da Aldobrandini e Lodovisani.

Bevilacqua di questo non occorre parlarne.

Madruccio è buon signore ma è troppo libero.

Barberino è troppo giovane, amico della sua openione, ha mostrato di sapere troppo, non è accetto a Spagnoli né alli Aldobrandini, n* a Lodovisiani. E' portato da' Fiorentini, Francesi e Borghesiani.

Mellino è stimato troppo accorto, ha infiniti nepoti che li fanno nocumento notabile; è escluso da Francesi, Lodovitani, Aldobrandini; è portato da Spagnoli, Fiorentini, e Borghesiani.

Another account of the conclave is contained in the same document. Therein, Francesco Maria dal Monte is even called "papabile assai".[1]

[fol. 219r/v] l'Ill.mo S.re Card.l del Monte è la seconda creatura <di Sisto V>, Vescovo di Porto, abita in Roma, è nobilissimo per la discendenza vera dalla Casa delli Re di Francia; al presente Marchese con feudo libero imperiale. È papabile assai, Lodovesio con sua fazzione non lo rifiuta, Borghese con la sua per terzo lo desidera in estremo,

[1] Cf. ASF, Carte Strozziane, prima serie, 226; fols. 219r-225v.

con li Spagnoli si è affatto aggiustato di modo tale che sicuramente non l'escludono, ma non lo chiamano. Medici lo porta tanto che gli nuoce assai in qualche parte, li francesi l'amano assai: è vecchio e così [butti] questi buoni incontri non gli possono giovare, se non con l'esclusiva p.ma delle fazioni papali, et così per terzo è in gran rischio. L'Ill.mo S. Card.l Borromeo Milanese (...)

Chapter II

Documents relative to Guidobaldo's interlocutors

The present chapter exposes information about life and work of Guidobaldo's interlocutors and collaborators intending, in this way, to facilitate the lecture and contextualisation of the precedent chapters. The first section II.1 contains short biographical descriptions (in alphabetical order); the second one, in contrast, reports documents relevant for a reconstruction of their biographies (and possibly works).

II.1 Short biographical descriptions of Guidobaldo's interlocutors, collaborators and acquaintances

The present section presents biographical information about the most important interlocutors and collaborators of Guidobaldo who have been named in the precedent parts of this doctoral thesis. The presented biographies vary in the extent of their attention to detail: this depends on the often extremely scarce data about Guidobaldo's interlocutors.
As exposed in the precedent chapters, especially two environments can be made out which had a not secondary impact on Guidobaldo's work: on the one hand, the circle of interlocutors with philosophical-mathematical interests, among them Curzio Ardizi, Tiberio e Virginio Almerici, Bernardino Baldi, Cesare Benedetti, Federico Bonaventura, Count Tommaso of Carpegna, Pier Matteo Giordani, Camillo Mazza and Jacopo Mazzoni; and a group of technical collaborators like Girolamo Arduini, Simone Barocci, Pietro Griffi, Francesco Guerrini, Giovan Giacomo Leonardi, Muzio Oddi, Nicolò Sabbatini and Count Giulio da Thiene.

Ludovico Agostini[1]

L. Agostini (1536-1612) was an author of some importance for the genre of the political utopia. In his writings, he dealt with religious and moral questions, often referred to politics and inspired by the socio-cultural climate of the Counter-Reformation.
Like many of Guidobaldo's interlocutors and acquaintances (Francesco Maria dal Monte, Bernardino Baldi, Alessandro Barignani, Cesare Benedetti (?), Tiberio and Virginio Almerici), Agostini attended the *Studio* of Padua, studying law. But instead of becoming a lawyer, he dedicated himself to writing and preferred private isolation to the courtly life. Only towards the end of his life, seriously suffering from poor health, he assumed his first public function in the Duchy: in 1604, he became governor of the Castle of Gradara.
As far as his literary work is concerned, he composed poems, collected in the manuscript *Rime*, the *Discorso della qualità d'amor*, *Lettera all'Italia* and the *Esclamazioni a Dio*. Further, in the period between the 1583 and 1590, he composed the writing *L'infinito*, a dialogue between two symbolic interlocutors, the *Finito* (the representation of the human reason) and the *Infinito* (the divine wisdom), with inspirations from the *Genesis* and the *Exodus*. Its fourth part is the famous *Repubblica immaginaria*, the proposal of an utopian state. This writing "assures <Agostini> with good reasons a not negligible place in the history of the political and social utopia".[2]
Agostini was in contact with Guidobaldo and the dal Monte family at least from the 1570s; his friendship with the latter is documented particularly for the period around 1600. Further, he maintained relations to other interlocutors of Guidobaldo like Cesare Benedetti and Cesare Pucci (his cousin). For our purposes, especially his writing *Giornate Soriane* constitutes a precious testimony of the courtly life at Pesaro around the year 1570.[3]

Almerigo, Tiberio and Virginio Almerici

The (noble) Almerici family had some relevance in the political-administrative life of Pesaro. Three characters of it seem particularly interesting in our regard, namely Almerigo Almerici, his son Virginio and the latter's cousin Tiberio.[4] Letters between them, conserved at the Biblioteca Oliveriana, permit insights into

[1]For further information on L. Agostini, cf. L. Firpo, *Lo Stato ideale della Controriforma. Ludovico Agostini*, Bari, Laterza, 1957; L.S. Firpo *Ludovico Agostini. Le Giornate Soriane*, cit; G. Montinaro, *L'epistolario di Ludovico Agostini*, cit.; A. Asor Rosa, *Agostini Ludovico*, in "Dizionario Biografico degli Italiani", vol. I (1960).

[2]L. Firpo, *Lo stato ideale*, cit., p.5: "<La *Repubblica immaginaria*> gli assicura a buon diritto un suo luogo non trascurabile nella storia dell'utopia politica e sociale".

[3]Extracts of this work are exposed in Appendix I, I.2.3.

[4]A family-tree of the Almerici, stemming from the cover rear of BOP, ms 194, is exposed in Appendix II, II.2.

important happenings regarding political and cultural life in the Duchy of Urbino during the second half of the sixteenth century.[1]
"Capitano" Almerigo Almerici was active as military captain and had gained some reputation;[2] his son Virginio went to study at Padua in the early 1570s and was married with Girolamo Macigni; their matrimony gave birth to Giovanni Battista Almerici, an important local historian of the seventeenth century;[3] Tiberio went to Padua as well and studied law, at the end of the 1570s; he later occupied offices of some importance in the administrative-political life at Pesaro: in 1578 he was made "*Vicario delle gabelle*" of his home-town, a decade later he was several times its "*Gonfaloniere*".[4]
Virginio and Tiberio were of about the same generation as Guidobaldo, and seem to have been part of his mathematical-philosophical circle.[5]

Curzio Ardizi[6]

The noble Ardizi family had some importance at Pesaro. Curzio's father Girolamo Ardizi was one of the most active members of the Council of Pesaro and occupied the office of *Confaloniere* various times.[7] Besides, the published a *Memoriale d'Agricoltura* (Fano, Farri, 1592) and composed a *History of Pesaro*, which has survived thanks to the historian G.B. Almerici. Girolamo seems to have had three sons, namely Curzio, Fabrizio and Fabio, the latter having been active as secretary of Cardinal Farnese.
Curzio, born probably in the 1550s and died in 1606, dedicated himself to poetry. He was one of Torquato Tasso's closest interlocutors and friends, as not less than some thirty survived letters testify. As member of an important family, he had to fulfil also several tasks for the Dukes of Urbino; moreover, for a time he has been in the service of Duke Guglielmo Gonzaga as "*Cameriere della Chiave d'Oro*" at the beginning of the 1580s, and later of Pope Gregor XIV as "*Cameriere d'onore*". After the former's death in 1591, he turned to Pesaro and was elected, in 1595, member of the Council of Pesaro. He married a female member of the Ubaldini of Urbino, and had a son in 1603.

[1] Cf. BOP, particularly ms 194 and 1577. The most relevant for our purposes are transcribed in Appendix I, cf. particularly I.2.2 and I.2.3.

[2] Cf. BOP, ms 1577.

[3] Cf. BOP, ms 455, p. 435: Ranieri dal Monte conveyed them a property. Giovanni Battista Almerici, the author of the (locally) famous "Spogli", was born on April 4th 1590, cf. BOP, ms 455, fol. 358.

[4] Cf. BOP, ms 1577 and ASCP (BOP), Libri del Consiglio, 1580-1609, II C 1.

[5] Cf. BOP, ms 426, fol. 159 r/v; letter from Guidobaldo to Pier Matteo Giordani, August 10th 1588; see Appendix I, I.8.3.

[6] For further information about C. Ardizi, cf. M. Quattrucci, *Ardizio Curzio*, in "Dizionario Biografico degli Italiani", Vol. 4 (1962); further, see the documents exposed in Appendix II, II.2.

[7] Cf. ASCP (BOP), Libri del Consiglio, 1580-1609, II C 1: see particularly the entries of December of 1589 and August 1593.

Besides his literary interests, he seems to have had some formation in mathematics and mechanics, as he had been sent to draw maps of the fortification and surroundings of Tunis at the instance of Duke Guidobaldo II in 1573.[1] He apparently was a member of Guidobaldo's mathematical-philosophical circle,[2] and further was closely connected also with Bernardino Baldi, particularly at the beginnings of the 1580s – "il Sig.or Bernardino che continuamente ora conversa meco" – and with Pier Matteo Giordani: "io tenga viva memoria et l'abbia sempre tenuta del suo alto ingegno e sua gentile natura, che per non aver in quei paesi più altri da invidiar santamente che il Sig.or Guidobaldo e Lei".[3]

Girolamo Arduini[4]

The Arduini were another important noble family at Pesaro. "Cavaliere" Girolamo Arduini, born probably in the 1540s and died in 1601, had studied at Padua and was an architect of some relevance, also outside the Duchy of Urbino: he was commissioned to build the ducal Villa Vedetta in the early 1580s,[5] and was further involved in works at the other (ducal) villas Imperiale and Miralfiore. He appears in the "*liste della famiglia*" of Duke Francesco Maria II as member of the court;[6] some sources call him even "ducal architect".[7] He is said to have been responsible for the design of the fortification in Amiens;[8] his services seem to have been further requested also by the Duke of Mantua.
His contacts with Guidobaldo date back at least to the 1570s.[9] He collaborated with Guidobaldo in various occasions, regarding the works of Villa Miralfiore and in questions regarding military architecture, as a letter conserved at the Bib-

[1] Cf. Appendix II, II.2.

[2] Cf. BOP, ms 426, fol. 159 r/v; letter from Guidobaldo to Pier Matteo Giordani, August 10th 1588; see Appendix I, I.8.3: the letter cite "Arditio" without given name. Given Curzio's close connection witih Pier Matteo Giordani and Baldi, it seems plausible to identify the person in question with Curzio Ardizi.

[3] For the citations, cf. Appendix II, II.2.

[4] In Appendix II, section II.2, two other biographical descriptions are exposed, coming respectively from BOP 966 and 1063.

[5] For further information about the progress of the respective works, cf. BOP, ms 434.

[6] Cf. Appendix I, I.4.4 .

[7] It seems, however, that his title should be interpreted with some caution: also N. Sabbatini and M. Oddi, *inter alia*, are said to have beard it: apparently, it simply indicated an architect who had received commissions by the Duke and who, possibly, was part of the court (cf. the "payrolls", see Appendix I, I.4.4).

[8] Cf. Appendix II, II.2.

[9] In fact, a letter from Almerigo to Virginio Almerici of March 1st 1574 reports: " (...) Io ti arei desiderato di qua et ms. Tiberio medesimo, fra questi belli ingegni che spesso si trovano insieme circulando: il Mazzone, il Benedetti, il Tasso con questi altri gentiluomini, dottori novelli nostri soliti, et l'abbate <Francesco Maria dal Monte> insieme a quali s'accostano poi diversi gentilomini di spada e cappa, come il S.or Guidobaldo, il Cavaller <Girolamo> Arduino et altri. Ma m.s Tiberio nostro se ne piglia di longhe pasciute con il Tasso. (...) " Cf. Appendix I, I.2.2.

lioteca Oliveriana suggests;[1] further, he dedicated to him his treatise on military engineering *Trattato del modo di piantare e fortificare una città* (1569).[2]

Bernardino Baldi[3]

Bernardino Baldi (1553-1617) was a most prolific and versatile Renaissance scholar, his interests reaching from poetry over linguistics to mechanics. As far as his occupation with mathematics is concerned, he began his studies under Commandino, attended the University of Padua from 1573-75 – *inter alia* with lectures on the *Quaestiones Mechanicae* under Pietro Catena – and was afterwards part of Guidobaldo's mathematical-philosophical circle: in various letters, in the meantime entered at the court of Prince Ferrante Gonzaga at Guastalla (from 1580), he expressed his regret not to be present at the discussions of Guidobaldo's circle.[4]

His services to the Gonzaga were rewarded in 1585, by his nomination as abbot of Guastalla. Subsequently, his studies began to orientate towards theological and linguistic arguments. But he did not abandon his contacts to the Urbinate court and his interlocutors at Pesaro around Guidobaldo: particularly close relations were maintained with Pier Matteo Giordani, but also to Cesare Benedetti and Curzio Ardizi. With the former two, he was also involved in the posthumous editions of Guidobaldo's works *Problematum astronomicorum Libri septem* and *Cochlea*.

He returned to Urbino in 1609. Subsequently, he revived the studies on mechanics he had undertaken in his youth, also with P.M. Giordani's help.[5] His principal work on mechanics, the *In mechanica Aristotelis problemata exercitationes*, approached due to the request of Count of Carpegna (another interlocutor of Guidobaldo, cf. below), appeared posthumously in Mainz in 1621.

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[1] Cf. BOP, ms 434, fols. 15r-18r.

[2] Cf. BOP, ms 1063, tomo I, fol. 24r; see Appendix II, II.2.

[3] The last years were accompanied by a pleasant interest for Baldi's figure. To cite only a few of the recent publications, cf. B. Baldi, *In Mechanica Aristotelis Problemata Exercitationes*, Mainz, Albini, 1621. Revision of the Latin text and Italian translation by E. Nenci, vols. 2, Milano, Angeli, 2010; B. Baldi, *Bernardino Baldi, Le vite de' matematici. Edizione annotata e commentata della parte medievale e rinascimentale*, ed. by E. Nenci, Milan, Angeli, 1998; A. Becchi, *Q. XVI. Leonardo, Galileo e il caso Baldi: Magonza, 26 marzo 1621*, Venezia, Marsilio, 2004. A study on his biography is R. Amaturo, *Baldi, Bernardino*, entry in "Dizionario Biografico degli Italiani", vol. V (1963).

[4] Extracts of these letters are exposed in Appendix II, II.2.

[5] Cf. Appendix II, II.2.

Simone Barocci[1]

Simone Barocci (died in 1608), brother of the famous painter Federico, was the head of a renowned Urbinate workshop of scientific instruments which fabricated like compasses, sundials and precision balances. He is said to have learned the mathematical foundations required for his work under Commandino.[2] Barocci's activity was embedded in a generally fertile climate for the fabrication of technical instruments in the Duchy of Urbino, enriched by the presence of other master technicians like Pietro Griffi (cf. below), some of whom had come from Germany and Flanders.[3]
Particularly in the 1570s, Guidobaldo seems to have often frequented Barocci's workshop at Urbino – Oddi reports this information in connection with the Marchigian mathematician's invention of the proportional compass and a special kind of sundial.[4] But also afterwards their contact seems to have been regular. Important aspects of Guidobaldo's mechanical work seem to be related to the availability of high-precision instruments, as his theory of the Simple Machines and his theory of the isostatic balance.[5]

Cesare Benedetti

Cesare Benedetti (1540-1609), philosopher of Aristotelian orientation of some reputation, stemmed from a rather important family at Pesaro, among his antecedents a bishop of Pesaro and agents of the Duke.[6] He, too, was in the services of the Dukes of Urbino: it was he who was entrusted with the difficult diplomatic mission with the Duke of Savoy, in occasion of the accusal of betrayal against Francesco Paciotti and the arrest of his brother Orazio. In 1586, after Francesco Maria dal Monte's refusal of the episcopate of Pesaro, the office was offered to Benedetti, who accepted and assumed it until his death. In this context, he seems to have planned the establishment of a Jesuit Seminar at Pesaro.
Benedetti "adored Greek, Italian and Latin literature, and was in excellent pos-

[1] Some information about Simone Barocci is contained in F. Sangiorgi, *Committenze milanesi a Federico Barocci*, Urbino, Accademia Raffaello, 1982; in F. Vetrano, *La scienza del Ducato di Urbino*, Urbino, Accademia Raffaello, 2001.

[2] Cf. P. Bellori, *Le vite de' pittori, scultori et architetti moderni*, cit.; see Appendix II, II.2. This information is a precious hint at the connections between the world of the "technicians" and mathematicians in the Duchy of Urbino.

[3] A particular importance was assumed by the production of mechanical clocks: an in-depth study on this topic, together with prof. E. Gamba, is forthcoming.

[4] Cf. Appendix I, I.2.1.

[5] On the connection between Guidobaldo's theoretical work and his "experiences" with real (but high-precision) instruments, cf. his letter to Contarini of October 9th 1580 exposed in Appendix I, I.8.2; for Guidobaldo's theory of the isostatic balance, cf. Part B, chapter I.

[6] For further informations on the Benedetti family and their importance at Pesaro, cf. BOP, ms 466, fol. 327r/v.

sess of any most sublime philosophical and theological science":[1] unfortunately, though, there are no extant writings of Benedetti which would permit a better understanding of his philosophical work. In this context, his death impeded him from publishing a comment on the Psalms.[2] Anyway, his extraordinary acquaintance with Aristotle's work can be deduced from the fact that he taught and explained the Stagirite's work to Prince/Duke Francesco Maria II della Rovere, for not less than fifteen (!) years;[3] Further, he is said to have been even the teacher of Guglielmo Gonzaga in "literature, philosophy and theology".[4] As far as his exchanges with other scholars is concerned, he seems to have been well acquainted with Gian Vincenzo Pinelli,[5] and discussed his conceptions with Jacopo Mazzoni and Torquato Tasso.[6]
Benedetti appears to have been an important philosophical interlocutor of Guidobaldo: Baldi, in a letter of 1585, named him among the "talented gentlemen" around the Marchigian mathematician.[7] BOP, ms 758 (cf. Appendix I, II.2) confirms this fact, enumerating Benedetti amongst Guidobaldo's interlocutors, besides Federico Bonaventura, Jacopo Mazzoni, Bernardino Baldi, Galileo and Pier Matteo Giordani.

Federico Bonaventura[8]

The Bonaventura were one of the most important (noble) families at Urbino. Federico (1555-1602) was the son of Leonora Landriani[9] and Pietro Bonaventura: the latter was in the service of Guidobaldo II della Rovere as ambassador with the Emperor and as military captain, dying during the return from Malta (1558). Thus Federico had early become a semi-orphan and subsequently grew up at the court of Cardinal Giulio della Rovere at Rome; he seems to have turned to

[1] Cf. BOP, ms 1062, p. 133; see Appendix II, II.2.

[2] Cf. BOP, ms 455, fol. 328r; see Appendix II, II.2.

[3] It is the Duke himself who testifies this in his notebook: "On the 25th <January 1585>: I finished to see all works of Aristotle. I have struggled with them not less than 15 years, having been read to me mainly by Cesare Benedetti." Cf. F. Sangiorgi, *Diario di Francesco Maria II della Rovere*, cit. Benedetti must have had a remarkable reputation, since he was teacher of Guglielmo Gonzaga, as well, in "literature, philosophy and theology". Cf. Appendix II, II.2.

[4] Cf. BOP, ms 1062, p. 133; see Appendix II, II.2.

[5] Cf. BAM, ms. J 231inf., fol. 194r; letter from Guidobaldo to Pinelli, October 6th 1577.

[6] Cf. the letters of Tibero and Almerico Almerici to Virginio Almerici, in occasion of the courtly carnival 1574; see Appendix I, I.2.2.

[7] Cf. Appendix II, II.2.

[8] Further information about Federico Bonaventura is contained in R. Michelangeli, *I Bonaventura: una famiglia del patriziato urbinate*, Urbania, Stibu, 1999; sources for his biography are L. Firpo, *Bonaventura, Federico*, in "Dizionario Biografico degli Italiani", XI (1969); G. Colucci, *Antichità Picene*, Tomo 26, Fermo, Colucci, 1796, pp. 165-167; C. Grossi, *Uomini illustri di Urbino*, Urbino, Guerrini, 1819, pp. 58-66; and the manuscript BUU, Fondo dell'Università, vol. 78. A part of Bonaventura's works is still unedited and conserved at the Biblioteca Oliveriana, cf. G. Mazzatinti, *Inventari dei manoscritti delle biblioteche d'Italia*, cit.

[9] Also the Counts Landriani had a notable role in the political life of the Duchy.

Urbino at the age of eighteen (1572).[1] Successively, he appears to have studied with Prince Francesco Maria, surely philosophy, possibly also mathematics (under Commandino). He held offices of notable importance in political-administrative regard, as *Gonfaloniere* at Urbino or as ambassador in the Duke's name with Gregory XIV (1591), Margarita d'Austria and Philip III (Ferrara, 1598). In 1577, he married Pantasilea Carpegna, sister of Count Tommaso Carpegna, and had numerous children.

Figure II.1: A portrait of Bernardino Baldi.

Figure II.2: A portrait of Federico Bonaventura.

Bonaventura was something like the "court philosopher" – he, too, was a proponent of the Aristotelian philosophy. His particular relation to Francesco Maria II is testified by a letter that reveals that the Duke made use of Bonaventura's private library during his stays at Urbino. The former asked him to write his four books *Ragion di Stato* (began in 1601, but released posthumously only in 1623) which contains reflections of how to guide a state in the political-religious context of the Counter-Reformation.
Generally, Bonaventura was a very prolific writer; his works testify his versatile interests spreading from politics, astronomy and astrology over natural philosophy to geography, with a pronounced orientation towards Greek philosophers like Ptolemy, Aristotle, Pliny or Theophrastus. This is documented by the following (only partial) list of his writings: in the early eighties, he worked on Themistios's paraphrase on Aristotle's *De Anima*; in 1592, a comment *Inerrantium stellarum apparitiones ac significationum collectio* of Ptolemy with texts of Pliny and Columella and *De Causa Ventorum Motus* in which he argued for the concordance in regard between Aristotle and Theophrastus; in 1600, he published *De natura*

[1] Cf. C. Grossi, *Uomini illustri di Urbino*, cit.

partus octomestris, with medical, juridical and astrological reflections on the premature birth. The works *Quomodo Calor a Sole Corporibusque Coelestibus producatur* and *De Via lactea*, defending again Aristotle's opinion, were published posthumously.[1]
Bonaventura was in contact with scholars like G.A. Magini, G.V. Pinelli, Guidobaldo and the members of his circle. A letter of 1588, in which Bonaventura and Guidobaldo discuss about the phenomenon of the tides, and the claim of BOP, ms 758, that the former was among his scientific interlocutors, testify their exchange of ideas about philosophical or mathematical topics. The estimation of Guidobaldo's circle towards Bonaventura is expressed by Baldi in his *Encomio della patria*.[2]

Count Tommaso of Carpegna[3]

Count Tommaso of Carpegna (1560-1610) belonged to an old, noble family,[4] which was a direct feudatory of the Emperor and occupied a territory in the strategically important region Montefeltro between the (Grand) Duchy of Tuscany and the Duchy of Urbino. Despite not being a direct subject of the Duke of Urbino, Tommaso of Carpegna was active as ambassador for Francesco Maria II: the extant documents testify various missions with Grand Duke Ferdinando I of Tuscany and a trip to Spain in 1599 to ensure the new king Philip III of Francesco Maria II's loyalty.
Letters of Guidobaldo to Pier Matteo Giordani and Muzio Oddi document that Carpegna belonged, with the two aforesaid scholars, to Guidobaldo's interlocutors and collaborators.[5] Interestingly, it seems to have been Tommaso of Carpegna who asked Baldi to write his *Exercitationes* (a comment on Aristotle's *Quaestiones Mechanicae*).[6] Further, a letter from his brother-in-law Federico Bonaventura testifies his interest in (the Aristotelian) philosophy and in astronomy.
Extant manuscripts written by the Count, *I Libri di famiglia*, unfortunately do

[1] Cf. L. Firpo, *Bonaventura, Federico*, cit.

[2] Cf. B. Baldi, *Encomio della patria*, Urbino, Monticelli, 1706, p. 121: "Grande e perpetua gloria guadagnò parimente a se stesso e alla patria colle nobilissime fatiche impiegate da lui intorno agli studi della filosofia Federigo Bonaventuri, nobilissimo gentiluomo, il quale fu di spirito oltremodo vivace, non altrimente che se egli avesse l'anima d'Aristotele."

[3] Further information on Count Carpegna is contained in T. di Carpegna Falconieri (ed.), *I libri di famiglia dei Conti di Carpegna-Scavolino (secoli XVI-XVII)*, San Leo, Società di studi storici per il Montefeltro, 2000.

[4] A member of the family is even nominated in Dante's *Divina Commedia*: "Guido Carpigna", Purgatorio XIV, vv. 98-99.

[5] Cf. respectively BOP ms. 426, fol. 176r; and BUU, fondo Congregazione di Carità, busta 47, fasc. VI, fol. 952r.

[6] It is in Baldi's funeral oration of Marcantonio Vergilii Battiferri that this hint is contained: "le *Questioni mecaniche* ch'ad istanza del Conte Thomasso Carpegna allora giovane, e Signore vago di simili studii, egli <Baldi> compose, nelle quali considerò la diffinitione del centro di gravità de' piani e de' sollidi, e delle proportioni."

not contain hints at his philosophical-scientific interests, but present political-administrative guidelines for his descendants.[1]

Alberico I and Alderano Cybo-Malaspina

The Cybo-Malaspina family had some importance as the reigning family in the region of Massa and Carrara (in today's Northern Tuscany): it had chosen to become vassal of the Holy Roman Empire under Alberico I (1534-1623), who was in turn nominated Prince of Massa and Marquis of Carrara in 1568. Since 1552, he was married with Elisabetta della Rovere, sister of Duke Guidobaldo II della Rovere: their first born son was Alderano (1552-1606), Marquis of Carrara, who would have died before his father and thus never governed the family.
Alderano passed some time at the court of Urbino and frequented Commandino's lessons of mathematics, becoming one of his most talented disciples: in fact, the latter dedicated him his comment on Aristarchus's *De Magnitudinibus et Distantiis Solis et Lunae* (1572), declaring to have complete "confidence in your most exquisite nature and in your outstanding and singular giftedness".[2]
A trace of his scientific contacts with Guidobaldo, facilitated by the fact that they contemporaneously attended Commandino's lessons, is contained in UCLA ms 170/624, whose folio 79 is commented by the former with "<Problems> proposed by Sir Marquis of Carrara": it contains two mathematical questions, whose first is reducible to the inclined-plane-problem, and the second relates to regular, geometrical figures.[3]

Giulio Giordani

Also the Giordani were a noble family of some importance in the political-administrative apparatus of the Duchy of Urbino.[4] Giulio Giordani (1550-1633) married in 1588 Vittoria, daughter of Giulio Veterani, first secretary of the Duke and influential councillor, and had one child Camillo. Giulio would have taken the place of his father-in-law at the Duke's side: after his juvenile education, presumably at the court of Urbino,[5] he went to study philosophy and art at Flo-

[1] Cf. T. di Carpegna Falconieri (ed.), *I libri di famiglia dei Conti di Carpegna-Scavolino (secoli XVI-XVII)*, ci.

[2] Cf. Aristarchus, *De Magnitudinibus et Distantiis Solis et Lunae*, transl. by F. Commandino, Pesaro, Franceschino, 1572; dedicatory letter, page ii (not numbered): " (...) quantumque in praestantissima natura eximioque ac singulari ingenio confidam tuo, declarare nunc liceat." A larger passage is transcribed in Appendix II, II.2.

[3] The document is transcribed in Part A, IV.1.2. It might be, however, that "Marquis of Carrara" refers to Alderano's father Alberico I; yet, as both Alderano and Guidobaldo were disciples of Commandino, and interested in mathematics, it seems more probable that the person referred to is Alderano.

[4] Cf. the Giordani family tree in Appendix II, II.2.

[5] Again, cf. Francesco Maria dal Monte's letter to Giulio Giordani of July 26nd 1608, cf. Appendix II, II.2.

rence at the end of the 1560s, in order to "return to Pesaro, endowed with those virtues which every gentleman ought to possess".[1] At the beginning of the 1570, he became secretary of Isabella della Rovere at Naples: the sister of Francesco Maria II della Rovere had married the Prince of Bisignano in 1565, on his part member of an influential family of the Reign of Naples. In the late '70s or early '80s, he must have turned to the della Rovere court in the Duchy of Urbino and became ducal secretary. In 1592, after the death of Giulio Veterani, he took his place as one of the most important persons in the administration of the Duchy of Urbino.
Giulio and his brother Pier Matteo Giordani (cf. below) were in close contact with the dal Monte house; they seem to have grown with Guidobaldo and Francesco Maria.[2] A prove of their respective friendship are the endings of their letters, usually underwritten with "fratello amorevolissimo" – most affectionate brother. Finally, Giulio seems to have enjoyed some mathematical formation, since Guidobaldo's letters to him refer also to mathematical topics.[3]

Pier Matteo Giordani

Pier Matteo Giordani (1556-1636), Giulio's brother,[4] was a man of letters with wide interests, from mathematics, mechanics over history and politics to theology and philosophy. His cordial friendship with Guidobaldo – Orazio dal Monte calls his father a "very close friend" of him –[5] went back to their childhood; moreover, Pier Matteo Giordani has to be considered his closest scientific interlocutor. His constant contacts also with Bernardino Baldi (who claimed himself as his "*amorevolissimo fratello*"), Muzio Oddi, Tommaso of Carpegna, Federico Bonaventura and Cesare Benedetti let him appear as the key character for a better understanding of Guidobaldo's scientific environment.
He began his scientific studies already in the 1570s, as from a letter of Baldi emerges.[6] This coincides with the period for which his intense interaction with

[1] Cf. BOP, ms 923; Giulio Giordani's letter to his father of December 20th 1567, BOP, ms 923 (letters without numeration, but in chronological order); see Appendix II, II.2.

[2] Cf. the letter of Francesco Maria to Giulio Giordani of July 26nd 1608, cf. Appendix II, II.2.

[3] For example, cf. BOP, ms 426, fol. 147r; Guidobaldo to Giulio Giordani; September 4th 1575: "Desidero che guardiate nell'almanacco e che vediate giusto il dì dell'equinottio, e che in tal dì vediate se nelli orologgi del Conte Giulio la punta dell'ombra va su la linea *aequinoctium* e che in segreto me lo avisiate." Further, BOP ms 426 fol. 151r. testifies that Guidobaldo sent him a copy of his *Planispheriorum universalium Theorica*.

[4] Cf. the Giordani family tree in Appendix II, II.2, "Giulio Giordani".

[5] Cf. BOP, ms 412, fols. 41r-42v; October 29th 1608; Orazio dal Monte to Pier Matteo Giordani: "mio Padre suo amicissimo"; see Appendix I, I.7.3.

[6] Cf. BOP, ms 430; fols. 17r-18v; Baldi to P.M. Giordani; December 8th 1578; see Appendix II, II.2.

Guidobaldo begins to be testified:[1] a prove of its constance are the letters of Guidobaldo's interlocutors that persistently gave their regards to the latter through Giordani. Remarkably, Baldi claimed to be envious about his "destiny to be able to enjoy Sir Guidobaldo each day".[2] Concrete traces of the scientific collaboration between Giordani and Guidobaldo are contained in the latter's letters, in his manuscript *In quintum Euclidis Elementorum Librum Commentarius Opusculum*,[3] possibly in some pages of the *Meditatiunculae*, and in UCLA, ms 170/624.[4]

Even if there are notices about (not specified) writings of him,[5] they do not seem to have survived. His occupation with geometry, mechanics and astronomy can be deduced only on basis of his correspondence (not only) with Guidobaldo.[6] He must have possessed a notable talent in these branches, given that apart from his collaboration with Guidobaldo he was consulted also by Orazio dal Monte (for the posthumous edition of Guidobaldo's works),[7] and by Baldi for the edition of the *Exercitationes*.[8]

Notable is also his interest in philosophy: his correspondence particularly with Fabio Albergati reveals his occupation with philosophic problems, like the concept of *idea* and its different relevance and meaning in Aristotle and Plato. His role in the creation of Albergati's *Dei discorsi politici libri cinque* seems to have not been secondary: the work criticised the political theory of Jean Bodin and defended Aristotle's.[9] Further, Giordani seems to have contributed also to the

[1]Cf. BOP, ms 1574; see Appendix II, II.2. Probably, however, they were friends already from Pier Matteo Giordani's childhood, cf. the entry "Giulio Giordani", in regard of the excellent relations between the dal Monte and the Giordani houses.

[2]Cf. BOP, ms 430 fols. 25r-26v; Baldi to Pier Matteo Giordani; November 4th 1581: "V.S. che ha in sorte di poter godere il Sig.r Guidobaldo tutto il giorno, se so che tutto il giorno anco debbe esser seco, intenderà da lui del mio restare in Italia, benché lo scriverlo anco a Lei non mi sarà molto di fatica."

[3]Cf. BOP, ms 630. The first one and a half pages of the manuscript are written by P.M. Giordani, before it is replace, in the middle of a phrase, by a different hand.

[4]UCLA, ms 170/624 contains a partial table of contents of the *Mediatiunculae* written by the hand of Pier Matteo Giordani: this proves that the latter had access to Guidobaldo's scientific notebook.

[5]Cf. BOP, ms 1063, pp. 35-37; see Appendix II, II.2.

[6]As far as the correspondence between Giordani and Guidobaldo is concerned, BOP, ms 426, fol. 153r speaks of a copy of Euclid's *Elements* that Guidobaldo had borrowed to P.M. Giordani. Other letters deal with mechanical topics (*e.g.* BOP, ms 426, fol. 176r); a serious of letters deals with the nova of 1604 (BOP, ms 426, fols. 185-190).

[7]Cf. Appendix I, I.7.3.

[8]Cf. BOP, ms 430, fol. 59r/v: "Molto Ill.re Sig. mio oss.mo (...) Spero tuttavia che <il libro> un giorno capiti e che V.S. mi favorisca del ricapito. Portarò con me un originale della mia fatica intorno le *Mecaniche*, e la potremo veder insieme. Io camino avanti nella fatica Geografica, ma col far molte miglia faccio poco viaggio. (...) D'Urbino a dì 17 novembre 1614."

[9]Cf. the letters exposed in Appendix II, II.2. Interestingly, also Guidobaldo and Giordani discussed about Aristotle's theory on politics, as from their letters emerges. Further information on Fabio Albergati (1538-1606) can be found in E.F. Guarini, *Albergati Fabio*, in "Dizionario

edition of some writings on history, above all of the *Historia di Francia* of his friend (and Guidobaldo's former disciple) Omero Tortora.[1]

Pietro Griffi[2]

Pietro Griffi (?-1590/91) was a rather famous clockmaker at Pesaro, in the service of Duke Francesco Maria II della Rovere: he appears as a member of the Duke's "famiglia".[3] The prohibition of the Duke of Urbino imposed on Griffi to work for others gives an idea of the esteem of his work. A clock, fabricated by Griffi for a certain Don Diego di Cordova seems to have aroused even the interest of King Philip II.[4]
Griffi was appreciated also by the exponents of the "scientific" world: Baldi calls him "uomo singolare nell'arte de' moti, e di maraviglioso ingegno" in his Latin translation of Heron's *Automata* (fol. 8r).[5] He collaborated also with Guidobaldo, who controlled the fabricated clocks of Griffi:[6] the fabrication of mechanical clocks and scientific instruments was an important characteristic of the scientific-technical environment of Pesaro and Urbino.[7]

Francesco Guerrini

The few biographic data there are about Francesco Guerrini report that he was an architect active at Pesaro and surroundings. Apparently, he was residing at Monte Baroccio: the Council Records of Guidobaldo's feud report regular wages to Francesco Guerrini, sometimes in relation to a "clock".[8] Further, he was also the architect of the community hall and tower at Monte Baroccio.[9]
Guerrini was disciple of Guidobaldo in "mathematics and architecture".[10] There are reasons to suppose that this instruction under Guidobaldo happened at the instance of the Duke of Urbino.[11] One of the reasons for this hypothesis is the

Biografico degli Italiani", Vol I (1960).

[1]Cf. Appendix II, II.2.

[2]Information on Pietro Griffi is contained in E. Gamba, *"La mano ministra dell'intelletto". Orologi e matematica a Pesaro nel secondo Cinquecento*, in "Pesaro città e contà", II (1992).

[3]Cf. Appendix I, I.4.4.

[4]Cf. E. Gamba, *"La mano ministra dell'intelletto". Orologi e matematica a Pesaro nel secondo Cinquecento*, in "Pesaro città e contà. Rivista della Società pesarese di studi storici", II (1992).

[5]Cf. Heron, *Degli automati, ovvero macchine semoventi*, transl. by B. Baldi, Venezia, Bentoni, 1589.

[6]Cf. Appendix I, I.3.3

[7]An article on this topic, together with prof. E. Gamba, is forthcoming.

[8]Cf. ACM, Libri del Consiglio, 1600-1622, fol. 97r; fol. 106r; fol. 111r; see Appendix II, II.2. The entry "clock" might refer to the maintenance of the clock on the communal tower.

[9]Cf. G. Allegretti, *Monte Baroccio*, cit.

[10]Cf. D. Bonamini "Abecedario degli architetti e pittori pesaresi", ed. G. Patrignani, in "Pesaro città e contà", VI (1996); see Appendix II, II.2.

[11]Cf. Part A, VI.1.2.

fact that Guerrini apparently taught mechanics to interested scholars at Pesaro, as a letter to Clavius testifies, in which he asks explanations about the concept *centre of gravity*.[1] This happened after Guidobaldo's death, and seems to be a hint at an organisation of a mathematical instruction in the Duchy of Urbino, independently from Guidobaldo's person. Further, it seems that he was involved in the posthumous editions of Guidobaldo's *Cochlea*.[2]

The Leonardi family

The Leonardi family assumed some importance in the political and scientific life of the Duchy of Urbino in the sixteenth century: Giovan Giacomo Leonardi sen. (1498-1562) was a famous diplomat of the Urbinate court at Venice under Francesco Maria I della Rovere and writer of the *Principe cavaliero*, in 1540 nominated Count of Montelabbate. His interests included also mechanics and military engineering, as his treatises *Trattato di armi e artiglieria* (1540) and *Libro delle fortificazioni dei nostri tempi* (1553) document.[3]
Probably, Tommaso Leonardi of Fano is part of the same family: the few known facts of his life document that he occupied himself with astronomy and algebra discussing about it with Federico Commandino.[4]
Giovan Giacomo Leonardi (jun.) was soldier in the service of the Venetian Republic and had been disciple in "mathematics and fortifications" under Guidobaldo and Giulio da Thiene.[5]

The Mazza family

Little is known about the Mazza family: a letter of Guidobaldo suggests that a certain Camillo Mazza was part of the circle of scientific interlocutors around the Marchigian mathematician.[6]
Information about other members of the family reveal that it had some importance in the political-administrative life of Pesaro and the Duchy of Urbino:

[1] The letter is exposed in Part A, II.3. Interestingly, the subject of these lessons was the *Mechanicorum Liber*.

[2] Cf. Appendix I, I.7.3.

[3] For information about Giovan Giacomo Leonardi sen., cf. V. Mandelli, *Leonardi Giovan Giacomo*, entry in "Dizionario Biografico degli Italiani", vol. LXIV (2005).

[4] Cf. V. Montebelli, *Commandino algebrista*, talk at "Federico Commandino (!509-1575), Umanesimo e matematica nel Rinascimento Urbinate".

[5] This information is given in E. Concina, *La macchina territoriale. La progettazione della difesa nel Cinquecento veneto*, Bari, Laterza, 1983, p.80: «La capacità di tracciare "disegni de' forti, baloardi, siti et piante di fortezze" gli risulta <a Giovan Giacopo Leonardi> – c'informa il suo stato di servizio – dall'educazione alle "matematiche et forificationi sotto la disciplina del Signor Guido Ubaldo de' Marchesi del Monte, conte Giulio Tiene et altri.»Concina refers, on p. 216, to BNMV, mss P.D.C. 951 "*Milizia navale e terrestre*", n.19: *Servizi militari del Co. Cap.o Gio. Giacomo Leonardi da Pesaro.*

[6] Cf. Appendix I, I.8.3: Guidobaldo to Pier Matteo Giordani, August 10th 1588.

Cavaliere Pompeo Mazza was member of the Council of Pesaro.[1] Presumably the same "Cavalier Mazza" was member of the guard of honour that accompanied Pope Clement VIII from Senegallia to Pesaro, in occasion of the latter's journey to Ferrara in 1598.[2] In 1581, a certain Pier Antonio Mazza approached Count Giovanni de' Tommasi in a financial problem: among his brothers, he names the "Cavalier Mazza".[3]

Jacopo Mazzoni[4]

Jacopo Mazzoni (1548-1598) was a philosopher, whose work is generally characterised by the attempt to show the convergences of various philosophical schools, particularly Plato's and Aristotle's. He reached a high reputation as the numerous invitations by Dukes and Popes show. *Inter alia*, he spent some years at the ducal court of Pesaro, being also a kind of teacher of Duke Francesco Maria II.
After first studies at Bologna, he began to attend the *Studio* at Padua in November 1563, mainly under the Aristotelian philosopher Federico Pendasio. It seems to have been in this period that he came to know Guidobaldo and Francesco Maria dal Monte, with whom he became friend: Mazzoni dedicated his *Discorso de' dittongi* (1572) to the latter,[5] and in 1574 he was guest of the dal Monte family in occasion of the festivities of the courtly carnival. Mazzoni was one of the protagonists of the discussions about philosophy and literature held together with Torquato Tasso, Pino of Cagli and Guidobaldo's philosopher-friend Cesare Benedetti, remarkably in presence of the Prince and Duke of Urbino.[6]
In 1574/75, he was member of the new Duke's court for almost a year. This period coincides with the final phase of his works on the immense *De triplici hominum vitae* (begun in 1567, published in 1576), where he approached the systematisation of those days' knowledge in three dominions, namely the *vita activa*, *contemplativa* and *religiosa*: he emphasises the common aspects in Plato's and Aristotle's philosophical work and their accordance also with other philosophies. Parts of the work seem to be influenced by the general cultural climate of the ducal court in Pesaro:[7] notably, Mazzoni includes questions relative to mechanics and fortification in his work.[8]

[1] Cf. ASCP (BOP), Atti del Consiglio 1580-1609, II C 1, fol. 79r. The sitting of the Council of May 1588 is an example of Pompeo Mazza's involvement in the local politics.

[2] Cf. BOP, ms 434, fol. 242v.

[3] Cf. BOP, ms 426, fol. 67r/v.

[4] For information on Mazzoni's life and work, cf. F. Purnell, *Jacopo Mazzoni and his Comparison of Plato and Aristotle*, PhD-thesis, Columbia University, 1972; A. De Pace, *Le matematiche e il mondo*, Milano, Angeli, 1993; D. Dalmas, *Mazzoni, Jacopo*, entry in "Dizionario biografico degli Italiani", Vol. LXXII (2008).

[5] Cf. Appendix II, II.2.

[6] Cf. Appendix I, I.2.2.

[7] Cf. Part A, chapter II.

[8] Cf. Appendix II, II.2.

He passed the following years at Rome and Macerata, working on other works like *Della difesa della Comedia di Dante*. In 1588, he was offered the professorship at the *Studio* of Pisa, where he stayed until 1597 and held the ordinary lecture on Aristotelian and the extraordinary on Platonic philosophy. In this period, he became scientific interlocutor of Galileo. Guidobaldo expressed his envy to Galileo to be unable to be present at their discussions and makes Galileo repeatedly refer his greetings to Mazzoni. In effect, Guidobaldo and his environment (Pier Matteo Giordani, Baldi, Albergati etc.) paid considerable attention to Mazzoni's philosophical work.
Also in Tuscany, the latter must have gained a notable reputation as it was he who held the funeral eulogy in occasion of Caterina de' Medici's death, in January 1589 at Florence – as he had already done at Urbino in 1574, in occasion of the death of Duke Guidobaldo II della Rovere.
In 1597, the year before his death, he published the work *Praeludia* in which he turned to compare Plato's and Aristotle's philosophical work. In this occasion, he partly revised his "juvenile" opinion about Concordism and about the possibility of conciliation of the two philosophies. In this occasion, he attended to the relation between mathematics and physics as well: his approach was favourable to the developments of "modern science" theorising the extension of the mathematical investigation to the study of physical phenomena and bodies.[1]

Muzio Oddi[2]

M. Oddi (1569-1639) was active as architect and mathematician, representing with Bernardino Baldi the most prominent exponent of the "School of Urbino" of the generation after Guidobaldo. After a failed attempt to become painter in Federico Barocci's workshop, he dedicated himself to architecture and mathematics, under his uncle Nicolò Genga and Guidobaldo dal Monte. For a certain time, he was one of the architects in the service of Francesco Maria II della Rovere, but worked also outside the Duchy of Urbino, as architect of the Holy House of Loreto, as military engineer in Bourgogne or as supervisor of the town walls' completion at Lucca.
Remarkable is the troubled relation he had with the Duke of Urbino: he attracted negative attention for having fished in a reserve and having gone swimming naked; objects belonging to the Duke's wardrobe were found in his home. The charge of conspiracy against the Duke led to his imprisonment at Pesaro from 1606 to 1609, followed by his exilement to Milan; only years after Francesco Maria II's death he turned to Urbino where he finally obtained the professorship at the university.

In his phases at Pesaro and Urbino, Oddi was in close contact with various members of Guidobaldo's circle, like Pier Matteo Giordani and Count of

[1] Cf. A. De Pace, *Le matematiche e il mondo*, cit.

[2] On Muzio Oddi, cf. particularly E. Gamba, V. Montebelli, *Le Scienze a Urbino nel tardo Rinascimento*, cit.; and A. Marr, *Between Raphael and Galileo*, cit.

Carpegna. Letters of Guidobaldo directed to him suggest that the constructed scientific instruments for the Marchigian mathematician. Some of his works, like the *Fabrica et uso del compasso polimetro* (1625) and the *Degli horologi solari* (1638), contain precious information on Guidobaldo's work.

The Pucci family

A letter of Guidobaldo suggests that a certain "Padre Pucci" was part of the circle of scientific interlocutors around the Marchigian mathematician.[1] The member of the Pucci family referred to could be Cesare Pucci,[2] but this identification has still to be confirmed.
Cesare Pucci (died in 1603) seems to have been a figure of some importance in the political life of Pesaro and the Duchy of Urbino: he was member of the guard of honour that accompanied Pope Clement VIII from Senigallia to Pesaro, in occasion of the latter's journey to Ferrara in 1598.[3] He further was member of the Council of Pesaro in the 1590s.[4] Moreover, he seems to have been in close contact with Cesare Benedetti,[5] and with Ludovico Agostini, his cousin.[6]
Another member of the Pucci family is Ettore, who was secretary of Lavinia della Rovere. Information about other members of the Pucci family is exposed in Appendix II, II.2.

Nicolò Sabbatini[7]

Nicolò Sabbatini (ca. 1574-1654) was an architect of some importance, as a list of construction sites under his responsibility evidence: the works at the port of Pesaro from 1613-1615; renovations at the ducal palace at Pesaro, the "Teatro del Sole" at Pesaro as well as another (ducal?) villa at Sant'Angelo in Vado.[8] Moreover, he was the author of the *Pratica di fabricar Scene e Machine ne' Teatri*[9] which is dedicated to the presentation of various machines required and used in the theatre. He is further said to have left manuscripts about civil and military

[1] Cf. Appendix I, I.8.3: Guidobaldo to Pier Matteo Giordani, August 10th 1588.

[2] The main argument of this attribution is Cesare Pucci's close connection with Ludovico Agostini and Cesare Benedetti, both of them interlocutors of Guidobaldo.

[3] Cf. BOP, ms 434, fol. 242v.

[4] Cf. ASCP (BOP), Atti del Consiglio 1580-1609, II C 1: see the sitting of the Council in April 1593.

[5] Cf. BOP, ms 211: this information is contained in several letters between Cesare Pucci and Giulio Cesare Mamiani. Benedetti is cited with "nostro Mons. Reverend.mo": note that he had become bishop of Pesaro in 1586.

[6] A letter of Agostini to Cesare Pucci is exposed in G. Montinaro, *L'Epistolario di Ludovico Agostini*, cit.

[7] A description of Sabbatini's life and work is contained in the "Encyclopedia Britannica", cf. "Nicola Sabbatini".

[8] Cf. Appendix II, II.2.

[9] N. Sabbatini, *Pratica di fabricar Scene e Machine ne' Teatri*, Ravenna, Paoli, 1638.

architecture,[1] but it does not seem that they have survived.
He himself states in the *Pratica di fabricar Scene* that he was "a good disciple" of Guidobaldo. A local historiographer of those times, Sebastiano Macci (born in 1558), specifies the subjects of his instruction under the Marchigian mathematician: civil and military architecture.[2]

Count Giulio da Thiene[3]

Giulio da Thiene (died in 1588) was active as diplomat, military captain and architect in the service of the Dukes of Urbino. As the "payrolls" of the ducal court reveal,[4] his position at the court was outstanding, his "provvisione" having been the highest of all members of the court.[5]
His mathematical talent seems to have been remarkable given that the Venetian mathematician Francesco Barozzi refers to Thiene like "Illustrissimo Comiti Iulio Thiene, viro praestantissimo, omnibus scientiis, arteque militari egregie versato":[6] this citation is made in the context of a reference to an instrument for drawing the hyperbola, apparently invented by Thiene. Further, he appears to have been in contact also with Giacomo Contarini.[7]
Also his role in the scientific environment of the Duchy of Urbino appears to have not been secondary: Baldi had originally had the intention to dedicate his translation of Heron's *Automata* to Thiene, only prevented by the death of the count. Even Guidobaldo's formation must have been connected to some extent and form with him: in a letter to Giulio Giordani, the former refers to a sundial of Thiene,[8] and an entry of the *Meditatiunculae* is explicitly entitled with "problem proposed by Count Giulio da Thiene".[9] Further, Thiene's involvements also in the formation of Prince Francesco Maria,[10] and of Giovan Giacomo Leonardi[11]

[1]Cf. Bonamini's *Abecedario degli architetti e pittori pesaresi*; see Appendix II, II.2.

[2]S. Macci cites Sabbatini's epitaph, revealing also the date of death (and implicitly also an approximate year of birth); cf. BOP, ms 382 fol. 281r: "Hic enim requiescit // Nicolaus ille // qui utriusque architecturae praecepta optime [ediscit] // Sub Guidone Ubaldo e Marchinibus Montis Italico nostri saeculi Archimede //Alios bene architectam docuit. // (...) // fere octuagentius obiit // VIII Kal. Januarii MDCLIV".

[3]For further information on Giulio da Thiene, cf. F. Lampertico, *Giulio Thiene, uomo d'arme e di scienza del secolo XVI*, in "Atti del reale Istituto Veneto di Scienze, Lettere ed Arti", XXXVIII 7 2 (1890/91).

[4]Cf. Appendix I, I.4.4.

[5]Another testimony of his close relation to the Duke is his letter to Federico Bonaventura (cf. BUU, Fondo del Comune, Busta 93, fols. 161r-162r; 28 novembre 1579): "Son chiamato da Sua Ecc.za a Caccia".

[6]Cf. F. Barozzi, *De admirandum illud geometricum Problema*, pp. 29-31.

[7]Cf. Heron, *Degli automati, ovvero macchine semoventi*, transl. by B. Baldi, Venezia, Bentoni, 1589: see the dedicatory letter.

[8]Cf. BOP, ms 426, fol. 147r.

[9]Cf. Part A, IV.1.2.

[10]Cf. Part A, I.2.

[11]Cf. Part A, IV.1.2.

suggest that he was active as instructor of mathematics and fortification. Finally, he seems to have been involved, like Guidobaldo, in the process of controlling the clock fabrication of the Duchy of Urbino.[1]

II.2 Documents on Guidobaldo's interlocutors, collaborators and acquaintances

The Almerici family

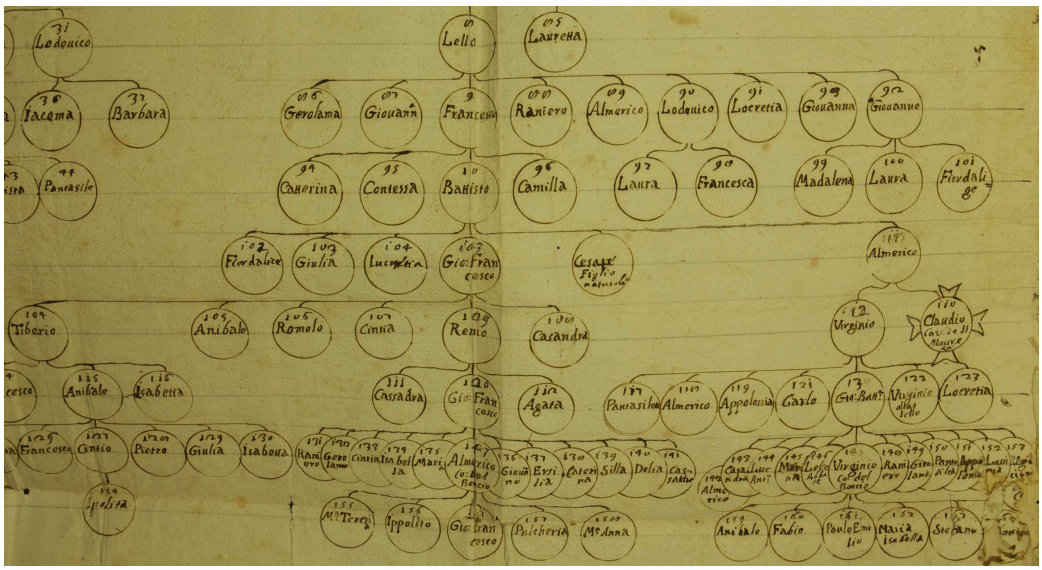

Figure II.3: A part of the the family-tree of the Almerici house, contained at BOP, ms 194. Virginio and Tibero, Guidobaldo's interlocutors, are reported in the fourth row from below.

Curzio Ardizi

The following document, a letter written by Ardizi to Pier Matteo Giordani, gives an idea about the former's connection to the circle about Guidobaldo, with close relations to Guidobaldo, Giordani and Baldi:[2]

> Molto mag.co Sig.or mio oss.mo,
> dal S.or Bernardino Baldi che ha scritto a lungo a V.S. potrà aver inteso quanto che nel forzato silentio senza mia colpa io tenga viva memoria et l'abbia sempre tenuta del suo alto ingegno e sua gentile natura, che per non aver in quei paesi più altri da invidiar santamente

[1] Cf. Appendix II, II.2. An article about this topic, together with prof. E. Gamba, is forthcoming.

[2] Cf. BOP, ms 425, fol. 75r/v.

che il Sig.or Guidobaldo e Lei, vorei poter rubarGli in qualche maniera poiché fin qui piace a Dio di concedermi ch'io non ne abbia auto poco buona maniera.
Desidero infinitamente d'intendere del stato Suo et del Sig.or Guidobaldo particolarmente, et della città tutta che è mill'anni che non ne ho aviso che mi sodisfi come già mi favoriva Lei; et perché desidero infinitamente di servirLe con tutto l'affetto ora mi riscaldo a pregarLe che mi comandano et che si degnano di scrivermi qualche volta che se V.S. ritornarà a favorirmi come già faceva e che mi ama, La si contenta adonque di darmi nova di M.s Claudio Saiani et del Cavalir Oratio Almerici, miei cugini, che fanno et in che si travagliano et tratengano, avendo pochi altri parenti in quella città ch'io ami più di loro e più desideri di servire. V.S. mi favorisca di fargliene fede et d'esortarli a comandarmi qualche cosa poiché è una infinità di tempo ch'io non so che sia di loro.
V.S. non si maravigli ch'io sia intrato così all'improviso in questi particolari che per discorere sopra della speranza che danno ora i gi<o>vani di Pesaro, il Sig.or Bernardino che continuamente ora conversa meco et è in camera mia, ne è stato cagione. Et insomma poi concludendo per il zelo ch'io ho dell'onor della patria et della grandezza sua, dico che desiderarei d'intendere che in essa da ogni parte sorgesero ingegni miracolosi come Lei et il Sig.or Guidobaldo, a quali con tutto quel maggior affetto che sia posibile bacio per fine le mani e viva felice! Di Mantova a dì 8 marzo 1582
Di V.S. m. M.
Ser.re aff.mo
Curtio Arditio

The next letter confirms Ardizi's connection to Pier Matteo Giordani in the 1580s: Baldi, in 1602, speaks to Giulio Giordani about a letter that his brother Pier Matteo had seen in company with Ardizi:[1]

> Gli anni passati gl'Accademici di Pavia mi vollero nel numero loro, a quali io mandai alcune mie compositioni e fra l'altre il detto libretto de madrigali composto da me intorno venti anni sono poco dopo, o quali nell'istesso tempo nel quale io venni a servitù del S. Duca Ferrara il che fu molti assai prima ch'io fossi prete, il che si può vedere dall'originale vecchio ch'io conservo in Urbino [ma] è la lettera data del 1582. Et il S. Piermatteo suo fratello può far testimonio che già molti anni sono lo vidde in Pesaro in casa di mio zio, presente il S. Curtio <Ardizi> studioso.

[1] Cf. BOP, ms 430, fols. 43r-45v; October 14th 1602.

The successive letter, from Curzio Ardizi to Duke Guidobaldo II della Rovere, reports about the former's trip to Tunis where he drew maps of the fortification and the surroundings:[1]

> Ill.mo et Eccll.mo S.or mi P.ron Ossr.mo
> Essendo io ritornato da Tunesi dove fui menato dall'Ill.mo S.or Ottavio Gonzaga a intercessione di Vostra Ecc.a conforme a quanto Ella per Sua infinita bontà si degnò allora racordarmi che facessi onore alla patria, non ho mancato mai, per quanto ha comportato il mio poco sapere et potere, di fare il debito mio.
> Et perciò ho preso ardire di darne anco segno all'Ecc.za V.ra et mandarLe come fo il dissegno di Tunesi della Goletta, del Forte nuovo, et di tutta quella riviera di Barbaria, che designai da quei luoghi più eminenti del Porto Farina, in quel miglior modo che ho saputo, il qual per esser stato da molti che furno, et ne hanno cognitione commendato per buono. Pure tal quale egli si sia, umilissimamente supplico V. Ecc.za a degnarsi di risguardarlo et conservarme per quel Suo fedelissimo sudito et servitore che Le sono, et con questo fine, con ogni umiltà me Le inchino a basciarLi la mano. Di Roma alli XVIIII Decembero MDLXXIII.
> Di V.E.
> Umilis.o et fedelis.o serv.re
> Curtio Arditio

The following extract of a letter from Torquato Tasso to Curzio Ardizi documents the friendly relation between the two men of letters. Further, it is a confirmation that Ardizi was in the services of the Duke of Mantua:[2]

> La lettera di V.S. in risposta dell'ultima mia mè stata in tutte le sue parti assai cara, ma carissima in quella, nella quale mi dà aviso dell'onorato luogo ch'ha appresso il Sig.or Duca di Mantova, ove non Le mancherà occasione di mostrar l'ingegno e giudizio Suo: me ne rallegro dunque con Lei quanto debbo, e debbo molto perchè molto stimo d'esser amato da Lei: e ricevo le lodi ch'Ella dà al sonetto et alla lettera mia come frutti del'amor Suo. (...).

This letter testifies also the exchange of ideas between Tasso and Ardizi: therein, the former answered to two questions of the letter (one of them: is honour eternal?).

[1] Cf. ASF, Ducato di Urbino, I, 127, fol. 1047r.

[2] Cf. BOP, ms 430, fols. 213r-216r. The letter contains the information "Di Ferrara il XX di [De.]bre" as hint to the date. As Ardizi is said to have started his service for the Duke of Mantua in 1580, the letter probably dates from the same year.

Girolamo Arduini

Information about Girolamo Arduini is contained in Domenico Bonamini's *Cronica della città di Pesaro* (BOP, ms 966, pp. 134/135):

> Fu in quest'anno <1581> che il Duca Francesco Maria II fece il Palazzo della Vedetta sul monte dell'<a Villa> Imperiale colla spesa di 36 mila scudi.[1] Sono persuaso che il primo architetto ne fosse l'istesso Duca, assai capace in ogni materia di scienza. Il disegno tuttavia fu fatto dal Cav.r Girolamo Arduini, primo di questo nome, di cui fece onora//ta menzione il nostro Omero Tortora nel libro XXII delle *Storie di Francia*.
> Fu costui un eccellente militare e bravo matematico, ed autore d'un manoscritto intitolato *Modo di piantare e fortificare una città* di pagine 24 in quarto.[2] Tale sua opera fu da lui dedicata al M.se Guid'Ubaldo del Monte. Nel tempo appunto che veniva richiesto dal Duca di Mantova per ingegniere nell'anno 1601 venne a mancare, carico d'anni e di meriti.

Additional information is contained in BOP, ms 1063, tomo I, fol. 24r/v:

> Arduini Cavalier Girolamo I
> Trovasi del Cavalier Arduini fatta degna memoria dal nostro Padre Zaconi, allorché parlò dei luoghi deliziosi assicurando che la Vedetta dell'Imperiale era da lui stata architettata. Ludovico Agostini nelle *Giornate Soriane* chiama i fratelli Cavalier Girolamo e Pauolo Arduini "due mattematici". Di Paolo non si hanno distinte notizie.
> Del Cavalier Girolamo, che fiorì circa l'anno 1540, si sa dal Faciolati *Fast. Gymn. Patav.*, p. 231, che studiò in Padova, dove fu sindaco dell'università. Quindi si pose a fare il militare e presso il Lancellotti per notizia a me datane esisteva un manoscritto, opera dello stesso Arduini col titolo *Grattato del modo di piantare e fortificare una città*, di pagine 24 in 4; il di lui manoscritto fu dedicato al Marchese del Monte l'anno 1569.[3]
> Morì il Cavalier Girolamo nell'anno 1601 come dall'elenco consiliare[4].
> Nell'anno 1601 8 giugno il Duca di Mantova richiede al Duca Francesco Maria II il Cav. Arduini, e non potendo lui qualch'altro che vaglia nella professione d'ingegnere. M.R. Tom. XI, fol. 176
> Di questo Girolamo Arduini esistono nella libreria publica Oliveri nel Tomo Titolo "Pesaro" 29 lettere originali quasi tutte dirette al Conte

[1] *in marg.* Fabrica della Vedetta all'Imperiale
[2] *in marg.* Il Cav.r Girolamo Arduini Architetto di detta Fabrica. Sue notizie
[3] il di lui ∼ l'anno 1569 *in marg. inf.*
[4] consiliare *correxi ex* consialiare

Tommasi[1]
Rimango sorpreso come i compilatori della Biblioteca Picena ne abbiano fatta la minima ricordanza. Parla del Cav.r Girolamo Arduini da Pesaro, prattico ed intendente militare ch'avea fatta la pianta della città d'Amiens il nostro Omero Tortora, lib. XXII, pag. 444.

Bernardino Baldi

The following letter documents Baldi's connection with other members of Guidobaldo's circle: besides obviously the recipient Pier Matteo Giordani, Curzio Ardizi, Giulio Giordani and Omero Tortora:[2]

(...) Il giovane che darà questa <lettera> a V.S. è quello, ch'io Gli dissi esser stato amalato d'umori malenconici; egli è gentilissimo e si diletta assai de' sonetti, e fra gl'altri di quelli del Tasso, e desidera di farne radunata. Però desidero che fra V.S. e m.s Curtio gli facciate parte di quelli, che vi trovate; è vero ch'egli non ha quella cognizione che si richiederebbe, per non aver atteso a lettere latine, ma con tutto quello aiutato dal giuditio piglia consolazione delle cose belle. Scrivo anco a m.s Curtio l'istesso che lui voglia favorire questo giovene e me insieme, di dargli tutte le cose del Tasso che vi trovate, ch'egli non abbia perché avendone lui molte, per quanto credo, quelle che resteranno[3] saranno poche.
Non mi occorre altro che dirLe se non che basci le mani al Suo Sig.r fratello <Giulio Giordani>, al Sig.r Omero Tortora infinitamente saluti, al m.s Mutio per replicarlo due volte, e che finalmente attenda agli studii come fa e non si scordi dello star sano e di più dell'avere un amorevolissimo fratello per tutto ove si trovarà, Bernardino Baldi.
D'Urbino a dì 8 dicembre 1578

Baldi's regular exchange both with Guidobaldo and with Pier Matteo Giordani, despite of his stay at Guastalla, is documented by the following letter:[4]

V.S. che ha in sorte di poter godere il Sig.r Guidobaldo tutto il giorno, se so che tutto il giorno anco debbe esser seco, intenderà da lui del mio restare in Italia, benché lo scriverlo anco a Lei non mi sarà molto di fatica.

His estimation of Guidobaldo is further expressed in the successive document:[5]

[1]Conte Tomasi *signo posito in marg.*
[2]BOP, ms 430 fol. 17r/v; December 8th 1578.
[3]quelle ∼ resteranno *in interl.*
[4]Cf. BOP, ms 430 fols. 25r-26v; Baldi to Pier Matteo Giordani; November 4th 1581.
[5]Cf. BOP, ms 430, fols. 23r-24v; Bernardino Baldi to Pier Matteo Giordani; October 17th 1583.

> Decide d'intendere qualche cosa del Sig. Guidobaldo perché io ho grandissimo timore che la lontananza m'abbia reso men vivo nella memoria sua di quello che doverei essere per l'amore et osservanza che io porto a la nobiltà et alle virtù sue. Prego V.S. che mi favorisca a baciarLi le mani a mio nome e far sì che io non sia privo de la sodisfazzione ch'io sento in saper solamente ch'Egli m'ami, e mi connumera fra i suoi servitori.

The following letter testifies that Baldi continued to occasionally frequent Guidobaldo's circle in the 1580s:[1]

> Venuta che sia la spedizione piglierò il possesso e poi me ne verrò a Urbino a ordinarmi dal Arcivescovo Gianotti e di là a Pesaro a goder un poco il S.r Guidobaldo, il S.r Cesare <Benedetti>, V.S. e gl'altri gentiluomini virtuosi.(...) Mi sarà favore segnalatissimo se bacierà le mani in mio nome al S.r Guidobaldo mio Sig.re et anco al S.r Cesare Benedetti e di tutti loro che io non gli scrivo aspettando di scrivergli cosa di già determinata e stabilita.

Baldi's contact with Pier Matteo Giordani was not interrupted in the following years, also in the period of Guidobaldo's exilement:[2]

> Ill. Sig.r mio sempre oss.mo
> Quando alla mia venuta a Pesaro penso di compensar il dispiacere dell'averla saputo ammalata col piacere di vederLa sana o almeno convalescente, trovo per mia mala sorte ch'Ella è a Fano, sicché mi ha paruta una strana cosa che in sei mesi di tempo che mi sono tratenuto in paese io non abbia potuto goderLa sei giorni, ma così vanno le cose di questo mondo. Lasciai la *Historia dela Vita di Federico* in mano di S.A.S.ma (...).
> Di Guastalla a dì 14 dicembre 1603

Interesting is also the following letter, which testifies Baldi's consultation of Pier Matteo Giordani in the works on his *Exercitationes*:[3]

> Molto Ill.re Sig. mio oss.mo
> (...) Spero tuttavia che <il libro> un giorno capiti e che V.S. mi favorisca del ricapito. Portarò con me un originale della mia fatica intorno le *Mecaniche*, e la potremo veder insieme. Io camino avanti nella fatica geografica, ma col far molte miglia faccio poco viaggio. (...)
> D'Urbino a dì 17 novembre 1614

[1] Cf. BOP, ms 430, fol. 27r/v; June 6th 1585.
[2] Cf. BOP, ms 430 fol. 71bis.
[3] Cf. BOP, ms 430, fol. 59r/v.

Simone Barocci

Information about Simone Barocci's is contained in P. Bellori, *Le vite de' pittori, scultori et architetti moderni*, Roma, 1672, p.175 (entry on Federico Barocci):

> Così da Ambrogio discesero due altri elevetissimi ingegni: l'uno fu Simone Barocci, fra moderni ancora il più eccellente nel lavorare gli stromenti matematici; perché studiando sotto la disciplina di Federico Comandino Urbinate, illustre ristauratore delle scienze matematiche, si diede a fabbricar compassi, squadre, astrolabi ed altre macchine, nelle quali acquistossi tanta fama che portò il nome suo, ed i suoi lavori in ogni parte ed arricchì la sua patria di sì nobile officina, che ancora dura in Urbino.
> L'altro figliuolo di Ambrogio fu il nostro Federico Barocci (...) .

The following extract of a letter, entirely exposed in the paragraph dedicated to Federico Bonavenutra, gives an idea about the reputation that Barocci had even in northern Italy: the famous Paduan scholar Gian Vincenzo Pinelli seems to have commissioned silver pen made by him:[1]

> Ill.re Sig.re Oss.mo
> Rendo somme gratie a V.S. per la penna d'argento ordinata costì a Ms. Simone <Barocci>, dal quale sarà bene aspettarla con suo comodo poiché nel resto mediante l'autorità di V.S. possiamo esser sicuri di doverne restare compitamente sodisfatti.

The fabrication of instruments is testified also for the mathematically interested scholars at Pesaro, by the following extract of a letter of Giulio Giordani to brother Pier Matteo:[2]

> (...) Camillo <Giordani> è tutto contento per aver avuto l'archipendolo dal Barrocci (..)

Cesare Benedetti

Information about Benedetti's life is contained in BOP, ms 1062, p. 133:

> Mons.r Cesare Benedetti Vescovo di Pesaro
> Cesare Benedetti, patrizio pesarese dell'istessa nobie famiglia dell'altro Giovanni Benedetti che nell'anno 1420 sedé nella Catedra Episcopale della sua patria, dopo d'aver dato ottimo saggio di sé, e della sua dottrina prima coll'imbevere nelle belle lettere, in filosofia, e teologia Guglielmo Gonzaga, quindi l'istesso nostro Francesco Maria II Duca

[1] Cf. BUU, Fondo del Comune, Busta 93, fol. 127r; October 7th 1594.
[2] Cf. BOP, ms 923; December 20th 1603; letters ordered chronologically.

d'Urbino ad istanza del medesimo grato Francesco Maria suo Signore decorato dal Pontefice Sisto V nell'anno 1586 5 giugno della chiesa di Pesaro, che ché abbia scritto Ughelli contro il sentimento del nostro Arciprete Gioseppe Alberti nella sua tavola dittica de' nostri vescovi inserta nel sinodio di Mons. Avio trafferì quell'autore l'elezione del Benedetti all'anno 1588 28 maggio, e non avendone riportata o citata alcune autentica prova pare a me più credibile il nostro Alberti che sembra difficil cosa sia si ingannato in questa piccola cirocstanza.
Fu questi un ottimo dottissimo prelato e molto sudò, molto fece a vantaggio della sua sposa. Al Benedetti dobbiamo l'acrescimento del numero dei canonicati. Al Benedetti, siccome amantissimo delle belle lettere e greche e italiane e latine, eccellente posseditore d'ogni più sublime scienza filosofica e teologica, siamo tenuti ancora dell'erezione a proprie spese del Seminario (...).

Additional facts about his life and work are exposed in BOP, ms 966 (D. Bonamini's *Cronaca della città di Pesaro*, pp. 138-139:

Non avendo accettato l'incarico episcopale <di Pesaro> Mons.r <Francesco Maria> del Monte, ad instanza dell'istesso Duca viene decorato dall'anzidetto Pontefice Sisto V il celebre Cesare Benedetti, nobile pesarese della casata del più antico Giovanni Benedetti, in vescovo di Pesaro li 5 giugno 1586, che che ne scriva l'Ughelli che posticipa la di lui assunzione ai 28 maggio 1588, ma io penso con errore.
Fu il Benedetti ottimo filosofo e teologo, ed ebbe l'onore d'essere prima Maestro di Guglielmo Gonzaga e quindi del nostro Signore Francesco Maria II. Uomo intendentissimo di belle lettere, non tanto greche che latine. Resse la Sua chiesa per lo spazio d'anni 23, mesi otto, giorni 24, morendo ai 6 di Febraro dell'anno 1609.
Abbelì la Sua chiesa cattedrale ornandola d'alcuni altare e fece molti altri benefici al suo gregge, essendosi sotto il di lui governo fabbricate molte chiese ed erette compagnie, come si dirà ai suoi luoghi. //
Eresse tre canonicati, ed a proprie spese edificò il seminario per i chierici innanzi la cattedrale sopra la porta del qual luogo leggevasi così:

PAULO V PONT. MAX.
FRANCISCO MARIA II FERETRO A
RUERE URBINI DUCE VI
CAESAR PISAUR. EP.<ISCOP>US EX PATRIA EIUS=
DEM CIVITATIS BENEDICTORUM FAMILIA
QUAE NON UNICUM HUIC SEDI
PROMERITUM DEDIT PRAESULEM
ORIUNDUS SEMINARIUM DOMUM CLERICIS

A SE INSTITUTIS AERE PROPRIO AEDIFICAVIT
ANNO MDCVII

A hint at his intellectual interests, about the writing of a comment on the Psalm is contained in BOP, ms 455 ("Spogli di G.B. Almerici"), fol. 328r:

> L'anno 1609, li 6 febbraio in venerdì sulle due ore di notte venendo il sabbato, morì il detto Monsignor Cesare <Benedetti> nell'anno settantesimo di sua età e ventitreesimo del suo vescovado. Lesse filosofia a Guglielmo Duca di Mantova et a Francesco Maria della Rovere Signore di questo città per opera di cui fu assunto al vescovado. Spese molti anni nel comporre una esposizione sopra i Salmi, opera molto stimata dagli intendenti, e mentre stava dandogli l'ultima mano, et era in maneggio di stamparla, venne a morte.

A document that testifies Benedetti's connections to Guidobaldo's circle is constituted by Baldi's letter to Pier Matteo Giordani of June 6th 1585 (BOP, ms 430, fols. 27r-28v). Baldi, in occasion of his ordination to the priesthood in 1585, announces to come to Urbino and Pesaro, and to have intention to meet with Guidobaldo, Benedetti, Pier Matteo Giordani, and the "other talented gentlemen":

> Venuta che sia la spedizione piglierò il possesso e poi me ne verrò a Urbino a ordinarmi dal Arcivescovo Gianotti e di là a Pesaro a goder un poco il S.r Guidobaldo, il S.r Cesare <Benedetti>, V.S. e gl'altri gentiluomini virtuosi.(...)
> Mi sarà favore segnalatissimo se bacierà le mani in mio nome al S.r Guidobaldo mio Sig.re et anco al S.r Cesare Benedetti di [???] loro che io non gli scrivo aspettando di scrivergli cosa di già determinata e stabilita.

This is confirmed by the biography of Guidobaldo in BOP, ms 758 (cf. Appendix I, II.2):

> <Guidobaldo> ebbe poi anco caro il conversar con i più vari Proffessori di queste scienze matematiche fra quali furno Mons.r Vescovo di Pesaro <Cesare Benedetti>, il S.r Federico Bonaventura, il S.r Mazzoni, Il S.r Abb.e di Guastalla, il S.r Galileo Galilei et il S.r Piermatteo Giordani, uomini di eccelse valore.

Federico Bonaventura

The Bonaventura family seems to have been in excellent relations with the Dukes of Urbino, already generations before Federico. Its members occupied important political, administrative and military offices.[1]

[1] Cf. BUU, Fondo del Comune, Busta 94, fols. 163r-164r. For further information, cf. also fols. 183r-184r.

> Gio. Batta medesimo poi prese Batista Gabrielli sorella e nipote del Card.e Gabrielli vescovo di Urbino. Ne nacquero Pietro e Guid'Antonio e attesero all'armi. Guid'Antonio fu Abate di due ricche abazie, fu Luogotenente del Duca Guidobaldo nella Compagnia d'uomini d'armi ch'[ei] teneva nel Regno di Napoli per il Re Cattolico. Pietro prese in moglie Eleonora de' Conti Landreani e dopo molti onori di guerra andò Ambasciadore all'Imperadore. Fu mandato con gente in soccorso di Malta e tornando morì. Fu molto caro a Guidobaldo, ma più al Cardinale suo fratello al quale scriveva con gran confidenza. Oltre l'essere valoroso in armi fu letterato e commendato dal <Annibale> Caro e da Bernardo Tasso.
> Ne nacque Federico che rimasto in tenera età senza padre fu dal Cardinale d'Urbino allevato come figliuolo nella sua corte e, con [tutte] l'occupazioni di casa e di corte, nella quale avea il primo posto appresso Francesco Maria ultimo Duca, ed i disturbi d'inimicizia, lasciò scritte molte opere. Sua moglie fu Pantasilea Carpegna, ebbe 12 figliuoli. Pietro il maggiore fu arcidiacono d'Urbino e da Urbano VIII dopo la devoluzione dello Stato fu fatto Vescovo di Cesena. Francesco Maria fratello di questo militò in Ungheria con il Conte Alessandro Landreani suo zio, fu ferito sotto Canissa, poi si fece Teatino. Rifiutò l'Arcivescovato d'Urbino offertoli dal Card. S. Croce. (...).

The following extract of a letter, between Virginio and his father Almerigo Almerici, hints at the possibility that "our" Federico Bonaventura could have held the prestigious office of *Gonfaloniere* at the end of 1574: it tells about a trip of the fresh-crowned Francesco Maria II and his court to Urbino:[1]

> Il S.r Duca Ill.mo partì di qua per Urbino martedì che fo alli 12 del presente <mese> accompagnato dei più nobili della corte (...) s'inviarno verso la corte et salite le scale il confalonero ch'era ms. Federico Buonaventura con li priori fecero ricercare in cammera a S. Ecc.a (...).

The particular relations between Bonaventura and Duke Francesco Maria II are underlined by the following letter: the latter seems to have had recourse to Bonaventura's private library during his Urbinate stays (typically in the summer months), and sent him, with the letter in question written by his intimate Count Giulio Cesare Mamiani, some books he had in two copies:[2]

> Ill.re Sig.re mio oss.mo
> Il Sig.re Duca Ser.mo m'ha ordinato che debba inviare a V.S. li presenti libri, quali Le saranno resi dal portatore di questa, dicendo S.A.

[1] Cf. BOP, ms 390, fols. 102r-104v.
[2] Cf. BUU, Fondo del Comune, Busta 94, fol. 55r.

> Ser.ma che questi sono de quelli che se ben si raccorda l'anno passato quando si fu costà se [mandava] a dimandare a Lei pensandosi che n'avesse nella sua libraria, et avendone trovato adesso S.A. averne de' doppi, m'ha ordinato che ne mandi a Lei questa parte, acciò li metta con gli altri Suoi libri; che come S.A. sarrà là su, se ne possa, occorrendo, servirsene. Siché sarà contenta riceverli, et a me sarà poi molto caro sentirne l'arrivo nelli suoi mani a salvamente.
> Con questa occasione vengo a raccordare a V.S. il mio continuo desiderio che tengo di servirLa et pregandoLa a favorirmi spesso de' sue occorenze, et a mantenermi vivo nella sua memoria. Per fine Le bascio le mani et Le prego da Dio ogni felicità. Di Pesaro li 29 di Maggio 1591
> Di V.S. Ill.re
> Aff.mo serv.re
> Giulio Cesare Mamiani della Rovere

As far Bonaventura's scientific work is concerned, he was in contact with Gian Vincenzo Pinelli, who he asked in several occasions for books: one letter of 1591 tells us that the Paduan scholar sent him a Greek book of Ptolemy.[1] Also the following one testifies the exchange of books between the two. It seems informative in regard of his studies. Further, the first phrase gives an idea about the reputation that Simone Barocci had also in northern Italy.[2]

> Ill.re Sig.re Oss.mo
> Rendo somme gratie a V.S. per la penna d'argento ordinata costì a Ms. Simone <Barocci>, dal quale sarà bene aspettarla con suo comodo poiché nel resto mediante l'autorità di V.S. possiamo esser sicuri di doverne restare compitamente sodisfatti.
> Ora io Le mando nota d'alcuni pochi autori del flusso et riflusso non reggistrati nella sua lista, dove quando sin qui non gl'abbia veduti V.S. vi troverà forse qualche cosa di nuovo, il che dico per conto del [Sagri] e del Marini, se ben questo parla più dell'altri movimenti delli mari[3].
> Quanto alla versione antica delli libri degl'Animali d'Aristotile io n'ebbi già un esemplare, ma tanto scorretto et di sì cattivo carattere che volentieri m'indussi a cambiarlo con un certo libro di mio gusto, essendomi però innanzi provisto della copia d'un altro esemplare simile, capitato nelle mani del Sig.r Hier. Mercuriale, di gran lunga migliore sì quel mio, se bene anch'esso difettoso[4]; et di tal copia ne sarà con

[1] Cf. BUU, Fondo del Comune, Busta 93, fol. 126r; April 26th 1591
[2] Cf. BUU, Fondo del Comune, Busta 93, fol. 127r; October 7th 1594.
[3] se ∼ mari *in interl.*
[4] se bene ∼ difettoso *in interl.*

questa un poco di saggio della prima carta[1] perché possa gustarlo ancora Lei, et dirmene appresso il suo parere o volere, che quando fusse così di sua sodisfatione si cercarebbe qui di persona che ne cavasse una copia fedele tale quale però[2].
Circa alla versione antica d'Aristotile et di quel tanto che se ne trova alla stampa, mi rimetto all'inchiusa carta. Nel resto io non sento lodar troppo l'editione greco-latina dell'Aristotile di Lione in foglio già che nel greco non si rende raggione alcuna dalle varietà delle lettioni, et nel latino non pare che si sia fatta quella buona scelta che si potea de' tradottori. Et come che il Cosabuona sia valentuomo, mostra tuttavia in questo libro avervi messo più costo la man sinistra che la diritta et fattolo a richiesta de' stampatori. Con che per fine le bacio la mano come dico al Sig. Cavaliere[3] Paciotto. Che N.S.re La conservi et contenti. Di Padova li 7 di ottobre 1594.
Di V.S. Ill.re
Aff. serv.
G.V. Pinello

Nel saggio che Le mando troverà V.S. parecchi difetti, ma nell'istesso modo sta l'originale con il quale è stato riscontrato diligentemente.[4]

The following letter testifies Bonaventura's dialogue with Pinelli about the topic of the tides:

Ill.re Sig.r Oss.mo
Ho veduto con piacere che la S.B. avesse ricevuta la mia lettera dove risposi alle sue dimande, in quel modo che mi fu lecito; sulle quali se gl'occorresse farmi qualche comandamento, io l'eseguirò con quella prontezza della quale me le trovo obligato per ogni rispetto.
Et perché in proposito degl'autori che trattano la materia del flusso et riflusso tra gl'altri ricorsi al Sig.r Gio. Batt.a della Porta come a persona curiosa et ultimamente [ho] risposto mi è parso bene far vedere a V.S. quanto mi ha scritto con aggiungere alcuni altri pochi autori delli quali sono stato avisato da un altro amico di Roma al quale parimente m'era voltato per servire più compitamente la S.B. alla quale resto con molto obligo della memoria che si compiacerà tenere.
Di quella penna d'argento che per desiderarla io per sodisfare a un mio caro amico non mi sono ritirato di darGli tale impavio, et come me farò intendere la S.V. il danaro che si ha da dare al maestro et la

[1] della prima carta *in interl.*
[2] tale quale però *in interl.*
[3] Cavaliere *ex* K.re
[4] Nel saggio ∼ diligentemente *in interl.*

via ch'averò da tenere per farglielo capitare, a tutto si darò spedizione quanto prima.
Non lasciarò anco di dire come mi sono meravigliato non poco di non aver veduto in una lettera del Silburgio portatami da questi librari tornati di fiera che non m'abbia risposto cosa alcuna in proposito di ristampare l'Anemologia migliorata et congiunta del testo greco. La onde in una mia lettera che le ho scritto quattro dì sono gliel'ho replicato di nuovo. Con che Le bacio la mano. Che N.S. la guardi.
Di Padova alli[1] di novembre 1594.
Di V.S. Ill. Aff. Ser. G.V. Pinello[2]

Further, for Bonaventura's contacts with Tommaso of Carpegna, cf. the paragraph "Count Tommaso of Carpegna".

Count Tommaso di Carpegna

A hint at Carpegna's interests in philosophy and astronomy is contained in the following letter, written from his brother-in-law Federico Bonavenura:[3]

Molto Ill.re Sig.r mio et Cug.no oss.mo
(...) Lodo il pensier di V.S. d'attender agli studi questo verno ma credo bene ch'all'impresa ch'Ella si pone, se per sé stessa altre volte non ne ha avuto lume o cognizione di logica et delle cose dell'anima. Trovarà non poca difficoltà [con] i libri della filosofia morale di Aristotele la[4] hanno scritto in lingua volgare et hano procurato dificultà assai. (...) Io non ho questi autori, Glili mandarei volentieri (...) quel[5] Suo astrolabio stupendo grande che comprò una volta et che me lo mandi quanto prima per [fretta] in posta, che voglio in quest'ozio fare alcune osservazioni dei moti celesti che ho gran tempo desiderato et lo riceverò per aver grandemente ne' dubbi che non sia tenuto et trattato con tutta la diligenza del mondo et rimanderò sana et salvo nelle sue mani. (...) In Villa a 21 di Agosto 1586
Di V.S. M. Ill.re
Serv.re et Cog.to Aff.mo
Fed. Bonaventura

Note that at the lower margin of the folio, a piece of about $10x20cm^2$ has been cut off, just were Bonaventura went about enumerating certain books – the motivation of this fact might be that some of the suggested works were put on the index, so that it was advisable to remove any trace of them.

[1] *post* alli *spatium unius verbi*
[2] Di V.S. Ill.ma ∼ Pinello *in marg.*
[3] Cf. ACP, Fondo Scavolino, 1 54; August 21st 1586.
[4] hoc *post* Aristotele la *deest pars folii dimensionis* $10x20cm^2$
[5] *ante* quel *deest pars folii dimensionis* $10x20cm^2$

The following letter, from the Grand Duke of Tuscany Ferdinando I to the Duke of Urbino, testifies Count Carpegna's activity as ambassador:[1]

> Ser.mo Sig.re
> Il Conte Tommaso di Carpigna ha così bene complito alla commissione di V.A. in remostrarmi la contentezza Sua di questo mio casamento, che per molto che mi abbia detto dell'affettuosa volontà Sua verso di me, non mi ha però apportato cosa nuova. Ma se bene molta consolatione dell'offitio che Le è piaciuto passar con meco, con la lettera Sua et con la vece del Suo gentilomo, di che La ringratio con tutto il cuore, per farLe conoscere sempre che Ella non ha alcuno che L'ami più di me, et che sia per mostraGliene con effetti, come farò io sempre che mi se ne porga l'occasione come intenderà più a pieno dall'ambasciatore Suo al quale rimettendomi Le bacio le mani et prego Dio che Le doni ogni prosperità. Di Fiorenza il dì X di maggio 1589.
> Di V. Alt.za
> Serv. Il Granduca di T.na

This mission was no isolated case, as the letter between Count Carpegna and the Duke of Urbino, exposed in Appendix I, I.5.4, reveals.

Alderano Cybo-Malaspina

The dedicatory letter of Commandino's comment on Aristarchus's *De Magnitudinibus et Distantiis Solis et Lunae* reads:

> ILL.MO AC NOBILISS.MO
> ALDERANO CIBO MALASPINAE
> CARRARIAE MARCHIONI
>
> Post Euclidis *Elementa* typis excusa, in quorum quidem editione, rogatu iussuque Francisci Mariae Principis Illustrissimi susceppta, cui ego et otium et studia omnia devovi mea, industriae atque laboris plurimum impendi, non inepte me facturum existimavi, Clarissime Alderane, si alium mox libellum plane aureum ac vetustissimum, a praestantissimoque philosopho Aristarcho *De Solis et Lunae magnitudine ac distantia* conscriptum, divulgandum proponerem. (...)
> Hunc igitur mea industria in pristinum nitorem restitutum et perpolitum, latinitateque donatum, una cum Pappi Alexandrini explicationibus quibusdam, sub tui Illustrissimi nominis tutela et patrocinio in lucem prodire volui, tum ut mei perpetui erga te amoris, atque atque observantiae specimen hoc esset, cum nulla alia ratione, quanti te

[1] Cf. ASF, Ducato di Urbino, I, 236, fol. 278r.

faciam quantumque in praestantissima natura eximioque ac singulari ingenio confidam tuo, declarare nunc liceat; tum ut tu, qui, summo loco natur, in magno generis // splendore et maiorum gloria, opibus, dignitate, gratia circumfluens et virtutum omnium atque artium optimarum miro incensus ardore, in quibus et tua sponte et studio, singularique constantia adeo processisti, ut nihil non amplum, non summum, non gloriosum de te sperandum sit, mathematicas disciplinas, quarum te incredibili desiderio flagrare novi, hac ratione habeas quam commendatissimas et magno praesidio tuearis. (...)

Giulio Giordani

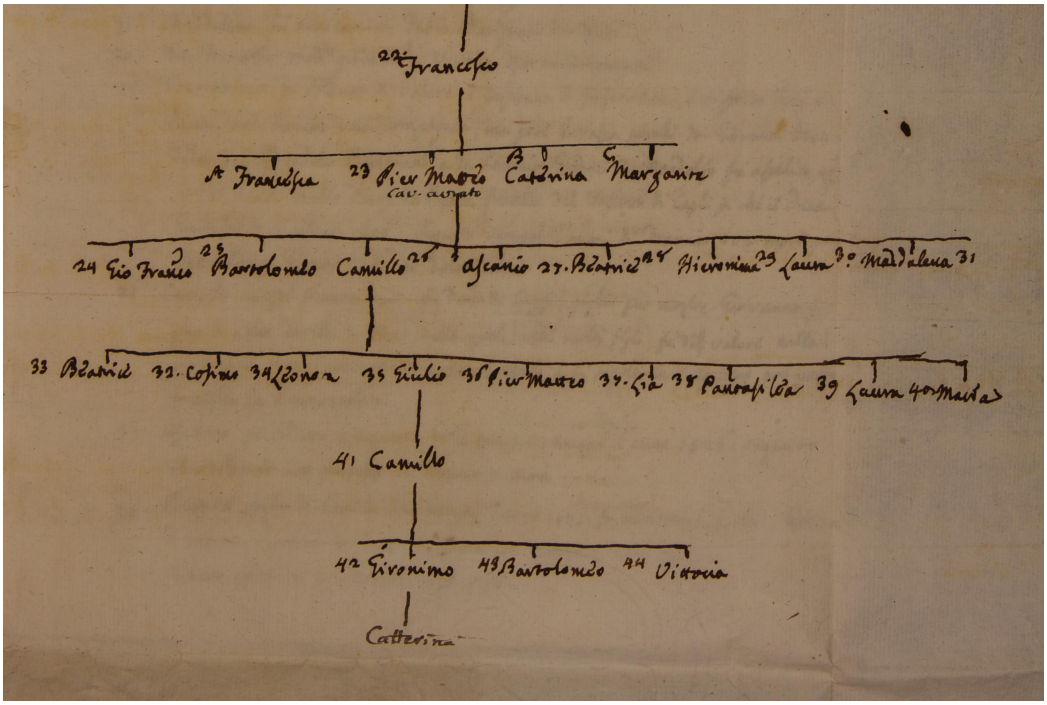

Figure II.4: The family-tree of the Giordani house. The brothers Giulio and Pier Matteo are represented in the fourth row.

Precious hints about Giordani's youth and formation are contained in the following letter sent to his father, conserved at BOP, ms 923.[1]

Molto mag.co et honor.do Padre
Poiché mi scrivete aver inviati i libri, credo che quelli che ultimamente vi chiedevo non saranno a tempo, però quando questo fosse, non

[1]The letter in question dates from December 20th 1567 (note that BOP, ms 923 does not report any numeration, yet at least a chronological order.

accede che vi piagliate fastidio altrimenti di mandarli, dico quelli sopra la logica, perch$\grave{}$ mi servivo di questi di Lelio, e con il tempo mi potrò accomodare. Oggi si sono fatte le vacanze alli studii, ma non per questo vesto di andare a m.s Pietro Vettorii ad udire una lectione privata dell'etica, et ogni giorno alla musica due volte; e fra un mese come comincio a cantare un poco più sicuro imparerò sonar di viola, e quanto per me si potrà mi sforzerò di tornare a Pesaro ornato di quelle virtu ch'a ogni gentiluomo si convengono. (...)
Mi scrivete per quest'ultima lettera che mi mandate 4 scudi per uno <servo> der Sig.r Ranieri <dal Monte> et io ho mandato più volte a casa del Sig.r Aurelio per vedere se egli era venuto, né mai è apparso, del che io poco mi maraviglio, e non credo che da Pesaro a qui ci sia tanto viaggio che in 15 giorni non possi esser arrivato. Vi prego, se non li avete mandati // a mandarli quanto prima, perché ne ho gran bisogno, come più volte Vi ho scritto.
Avvrei caro intendere se si farà la comedia del Pacciotto per questo carnovale e chi vi recita, et similmente esser fatto partecipe d'altri sucessi che sogliono accadere. Et non mi occorrendo dir altro, raccomandandomi alla nonna, al zio Capitan Ascanio, a m.s Fabio, et a tutte le zie e sorelle e fratelli faccio fine. Che il nostro Signore Iddio doni a tutti lunga e felice vita. Di Firenze il dì 20 di decembre del '67.
Di V.S. ubedientiss.o figliuolo
Giulio Giordani

Giulio Giordani had a close relation to the dal Monte house, testified by his ample correspondence with Francesco Maria dal Monte (cf. BOP, ms 426). Here is the transcription of a letter that is important to understand their excellent relations, from early childhood on when they stayed together at court:[1]

Ill.re Sig.re
Ho fatto con il Granduca l'offitio del quale V.S. mi ricerca in servitio del [S.r] Sempronio Sempronii acciò da S.A. sia raffermato Auditore di Ruota in Fiorenza et ne ho riportato che quando la relatione delle sue qualità sia conforme a quello che V.S. me ne scrive, egli resterà consolato, che è quanto devo dirLe in risposta; et La saluto per fine et Dio La contenti. Dalla Villa Ferdinanda a 26 di luglio 1608.
Di V.S. Ill.re

V.S. può essere sicurissima che un'amicitia di 55 anni non si può mai cancellare. Si ricorda quando giocavamo al pallone – *heu quanto*

[1]Cf. BOP, ms 426, fol. 115r; Francesco Maria dal Monte to Giulio Giordani.

melius â con le Artemisie, Cleopatre? Et pur passa ogni cosa. Io son Suo al solito et La saluto.
Come Fratello Amorevolissimo
Il Card.le dal Monte

The assurance about their friendship might be comprehended in basis of the difficult relation that Guidobaldo had in his last years with the Duke of Urbino and its court, including most probably also Giulio Giordani as ducal councillor.

Pier Matteo Giordani

Again, Bonamini's *Abecedario degli architetti e pittori pesaresi* (BOP, ms 1063, pp. 35-37), gives some information on the life and work of Pier Matteo Giordani, surely inverting the roles in respect to Guidobaldo, as far as the scientific interaction is concerned.

1560 Giordani Pier Matteo
Non è da confondersi questo Pier Matteo Giordani II coll'altro Pier Matteo amicissimo del Conte Baldassarre Castiglione vissuto sul principio del secolo XVI, come conoscesi dalle *Lettere* dell'autore del *Corteggiano*, libro II lettera XXII in data dei 22 aprile 1522.
Visse costui assieme con Giulio suo fratello ai tempi dell'ultimo nostro duca Francesco Maria II e fu alquanto più avanzato in età del marchese Guidubaldo del Monte che compiaquesi sempre frequentare l'amicizia e la conversazione di questo Pier Matteo Giordani, perché da lui molto imparava, conferendo circa i suoi studi mattematici, come si racoglie da un anonimo che lasciò le memorie scritte di quel gran letterate.
V'è tutto il fondamento di credere che questo sia quel Giordani lettore, eccellente nell'astrologia e nelle mattematiche e versato in ogni sorte di lettere ed in tutte le materie politiche, di che viene assai lodato dal Gallucci nel *Panegirico di Pesaro*, c. 31. Il di lui fratello Giulio Giordani morì ottagenario nel 1633 e di lui trovavasi il mausoleo di fini marmi nella chiesa di Sant'Agostino in Pesaro con bella inscrizione ora quasi dispersa ed abbandonata in qualche magazeno de quei religiosi.
Se deesi prestar fede all'abate Giovan Francesco Lancellotti, che di questo genere di cose tutto vide ed osservò, Pier Matteo Giordani lasciò dei manuscritti: m'è però ignoto su quale materia questi s'agirassero.
Egli è certo che l'Agostini nel fine della nona *Giornata soriana* chiama questo Pier Matteo Giordani col titolo di filosofo e Giulio di lui fratello lo dice segretario del duca Guidubaldo.

Giordani's occupation with mathematical and philosophical studies goes back to the 1570s, as the following letter of Baldi reveals:[1]

> (...) Non mi occorre altro che dirLe, se non che basci le mani al suo Sig.r fratello <Giulio Giordani>, al Sig. Omero Tortora, infinitamente saluti m.s Mutio, per replicarlo due volte, e che finalmente attenda agli studii come fa, e di più d'abere un amorevolissimo fratello per tutto ove si trovarà.
> Bernardino Baldi.
> D'Urbino a dì 8 dicembre 1578

This excerpt is at the same time a testimony of Giordani's close contact to other members of Guidobaldo's circle, namely Omero Tortora apart from Baldi and Giulio Giordani.
Quite impressive is the list of Guidobaldo's interlocutors who made him give their regards through Pier Matteo Giordani, exposed in the following: this testifies the closeness of their relation:
Curzio Ardizio, at Mantua, remembers "the miraculous great minds like you and Sir Guidobaldo, to whom I make a handkiss with the most profound affection possible".[2]
Bernardino Baldi, at Guastalla, is envious of P.M. Giordani about his "destiny to be able to enjoy <the conversations with> Sir Guidobaldo all days".[3] In another occasion, he asks Giordani to contact Guidobaldo, fearing that the latter has forgotten him.[4]
Also Fabio Albergati gave his regards to Guidobaldo through Giordani.[5]

This friendship with Guidobaldo must have dated at least from the 1570s: in fact, in 1577 a certain Ludovico Vitale had known that Guidobaldo had received a letter by Torquato Tasso; instead of contacting directly the Marchigian mathe-

[1]Cf. BOP, ms 430; fols. 17r-18v; Baldi to P.M. Giordani; December 8th 1578.

[2]Cf. BOP, ms 425, fol. 75r/v; March 8th 1582; Curzio Ardizi to Pier Matteo Giordani; see Appendix II, II.2, "Curzio Ardizi".

[3]Cf. BOP, ms 430 fols. 25r-26v; Baldi to Pier Matteo Giordani; November 4th 1581: "V.S. che ha in sorte di poter godere il Sig.r Guidobaldo tutto il giorno, se so che tutto il giorno anco debbe esser seco, intenderà da lui del mio restare in Italia, benché lo scriverlo anco a Lei non mi sarà molto di fatica."

[4]Cf. BOP, ms 430, fols. 23r-24v; Bernardino Baldi to Pier Matteo Giordani; October 17th 1583: "Decide d'intendere qualche cosa del Sig. Guidobaldo perché io ho grandissimo timore che la lontananza m'abbia reso men vivo nella memoria sua di quello che doverei essere per l'amore et osservanza che io porto a la nobiltà et alle virtù sue. Prego V.S. che mi favorisca a baciarLi le mani a mio nome e far sì che io non sia privo de la sodisfazzione ch'io sento in saper solamente ch'Egli m'ami, e mi connumera fra i suoi servitori."

[5]Cf. BOP, ms 402, fol. 30r; Fabio Albergati to PMG; November 22nd 1597: "si ché bacio a V.S.et al S.r Guidobaldo affettuosamente la mano."

matician, he approached P.M. Giordani, apparently already in close contact with the former, in order to have the letter.[1]

> Molto magn.co S.r mio oss.mo
> Mando a V.S. qui alligata la copia della lettera del Tasso scritta a S.Ecc.a come Le promisi, e desidero che non sia veduta da verun altro, se non è qualche Suo amico, che non sia per publicarla, che per avventura dispiaceria che fosse uscita fuori, sebene non importa più che tanto.
> V.S. si contenti mo' di farmi vedere una copia di quella che il detto Tasso scrisse al S.r Guidubaldo, che me ne farà gratia; et l'aspetto con molto desiderio.
> A ms. Camillo <Giordani> io feci la Sua ambasciata, per conto di quel libro della guerra giudaica. Bascio le mani di V.S., e pregoLe ogni contento. Di Urbino a 4 di Agosto 1577.
> Di V.S.
> Serv.re aff.mo
> Lodovico Vita<le>

Their friendship already in the 1570s does not astonish, as Guidobaldo was friend also with Pier Matteo's brother Giulio.[2]
Even if there is no mathematical writing of Pier Matteo Giordani extant, he must have been rather competent, as the following praising comments of his interlocutors Orazio dal Monte and Bernardino Baldi testify:
In the contest of the joint works on the posthumous publication of Guidobaldo's works, Orazio dal Monte confesses to Pier Matteo Giordani.[3]

> Onde laudo sommamente il prudentissimo suo parere, non mai fallace in queste esquisetezze si come in ogni cosa, io che per zelo di mio Padre suo amicissimo avrà risguardo al buono. (...) a me basta che venghi da Lei che per la domestica intrinsich[ezza] e per le dottissime qualità con che trattava con mio Padre [le figure] come così fatte da esso S.re.

Also Baldi consulted P.M. Giordani for his works on the *Exercitationes*, as the following letter documents:[4]

> Molto Ill.re Sig. mio oss.mo (...) Spero tuttavia che <il libro> un giorno capiti e che V.S. mi favorisca del ricapito. Portarò con me un

[1] Cf. BOP, ms 1574.
[2] Guidobaldo, in his letters to Giulio Giordani of 1573 and 1575, underwrites with "come fratello"
[3] BOP, ms 412, fols. 41r-42v; October 28th 1608. Other letters on this regard are exposed in Appendix I, I.7.3.
[4] Cf. BOP, ms 430, fol. 59r/v.

> originale della mia fatica intorno le *Mecaniche*, e la potremo veder insieme. Io camino avanti nella fatica Geografica, ma col far molte miglia faccio poco viaggio. (...) D'Urbino a dì 17 novembre 1614

Generally, Baldi was in excellent relations with the whole Giordani family. For example, he congratulates with Giulio Giordani's son Camillo (II) in occasion of the birth of a son, and emphasises to "love you with your whole family".[1] Remarkable is his exchange of ideas about philosophy with Fabio Albergati: apparently, Giordani sent to the latter own writings:[2]

> Io ho letta e riletta più volte la bellissima scrittura di V.S. e quanto più l'ho considerata più mi è piaciuta; e così le ne rendo mille e mille et infinite gratie e me ne farò honore.

Apparently, they discussed also about perspective, probably in context of Guidobaldo's works on the *Perspectivae Libri sex*; interestingly, a certain S.r Pendasio must have disagreed with Pier Matteo Giordani, and referred himself to the authority of Aristotle:[3]

> Io ho proposto la Sua dubitatione al S.r Pendasio sopra la Perspettiva, mi ha [detto] di voler vedere i luoghi di Aristotele e che poi mi darò la risposta et io quanto prima l'inviarò a V.S.
> Quanto mi siano piacciute le cose che nell'altra sua, e nell'ultima ancora mi ha favorito di scrivere, lo vedrà per gli [effetti], quando sarà tempo. Del confrontar il testo latino col francese della [opera] del Budino, non mi pare che occorra poich'egli è stato auttore dell'uno e dell'altro et a me basta [cavarmene] l'opinion sua. (...)

The following letter is interesting, as it testifies a discussion about the concept *idea* respectively in Aristotle and Plato, between Giordani and Albergati:[4]

> Con la cortesissima lettera di V.S. delli 4 <luglio> ho ricevuto la mia scrittura e La ringratio infinitamente degli avvertimenti e saranno da me osservati [adeguatamente], conforme alla stima che faccio del valor e giuditio di V.S. Solo una cosa ho da replicarLe ch'è sopra le idee.
> E prima che Aristotile dica che Platone le mostra solamente nelle sostanze non solo è detto *** nel capitolo VI del primo dell'*Ethica* ma in mille luoghi della metafisica, e tutti i Platonici lo confessano.

[1] Cf. BOP, ms 430, fol. 57r.; B. Baldi to Camillo (II) Giordani: "Molto Ill.re S. mio, alla nuova del primo figlio di V.S. e figlio maschio ho sentito quel di contento che può imaginarsi da Lei che sa quanto io l'ami insieme con tutta la sua casa. Me ne sono rallegrato col S. suo Padre <Giulio Giordani> ora me ne rallegro con esso Lei e col S.r suo zio <Pier Matteo Giordani> col quale intendo che sia commune questa mia. (...) D'Urbino a dì 18 agosto 1614".

[2] Cf. BOP, ms 402, fol. 30r; November 22nd 1597.

[3] BOP, ms 402, fol. 31r; Fabio Albergati to Pier Matteo Giordani; December 3rd 1597.

[4] Cf. BOP, ms 402, fol. 48r/v; Fabio Albergati to Pier Matteo Giordani; July 8th 1598.

> Di poi quanto al dire che l'argomento [solto] [proprio] da Aristotele dalle arti non vaglia [contro] le idee, essendo essi accidenti, si risponde che se bene Platone metta le idee solamente nelle sostanze non seguita che la ragione di Aristotile [solta] dalle arti [contro] di esse non sia valida e gagliarda per distruggerli. (...)
> Mi soviene di [più] a V.S. quello che nell'altra mia non Le dissi per conto della bellezza, cioè ch'ella non è oggetto della vista come proprio sensibile, perché il pp.o sensibile di cotal potenza è il colore, onde la bellezza come figura o sensibil *** l'è sottoposta. (...)

The historical interests of Pier Matteo Giordani is testified by his correspondence with Cesare Clementini, who wrote a *History of Pesaro*, for which he asked Pier Matteo Giordani's help.[1] Further, his correspondence with Omero Tortora evidences that he helped also in the latter's composition of the *Historia di Francia*: so, Omero Tortora asked his help in the compilation of his *Historia di Francia*.[2]

> Et per altro se ne può sperare aiuto notabile, ho risoluto di tirar inanzi et tra gli altri spero molto principalmente l'aiuto di V.S. la quale poiché sarà per esser di qua presto potrà vedere che la fattica è molta, et che per il sogetto nobile et eroico merita d'essere aiutata (...)
> Per fine di questa lettera la supplicare anche a veder alcune pietre, ch'io ho inviate a Pesaro, anzi ho [aviso] che siano di già arivate a salvamento per mettere a [meno] di miei padre et fratello, et se Ella può arivar col mio S. Guid'Ubaldo a S.to Agostino dove devono esser poste, per divisa ben il loco mi sarà di segnalato favore.

And in another letter he writes:[3]

> Quanto all'*Historia*, avei più di bisogno io farla veder a Lei che mi potria far migliorar molto con i suoi avertimenti ch'Ella di vederla per gusto, sono tuttavia ancora nella prima mano.

Francesco Guerrini

Here is what Bonamini writes about Guerrini, in his "*Abecedario degli architetti e pittori pesaresi*":[4]

> Signor Francesco Guerrini architetto
> Scrisse Pier Francesco Macci nella *Relazione dell'apparati per le nozze*

[1] Cf. BOP, ms 430.
[2] BOP, ms 415, fol. 24r.
[3] Cf. BOP, ms 415, fol. 30r-31v, 1 maggio 1602.
[4] Cf. D. Bonamini, *Abecedario degli architetti e pittori pesaresi*, ed. by G. Patrignani, in "Pesaro città e contà, VI (1996).

> *della principessa Claudia, c.20*, che il Signor Francesco Guerrini fu allievo nelle matematiche ed in architettura del famossissimo Signor Guidubaldo del Monte. Giovì tale notizia per indagarne delle ulteriori circa questo degno sogetto, che sospettasi con tutto il fondamento essere stato l'architetto della chiesa di Sant'Ubaldo, come da vari pagamenti a lui fatti dal nostro pubblico per tale effetto segnati nel *Libro mastro 1615*, cc. 419-567, si può sicuramente dedurre.
> La casa Guerrini esiste ancora in Pesaro, onde v'è tutta la probabilità che debba costui contarsi fra i nostri celebri architetti.

Bonamini transcribes, in the following, some of the bills, we do not expose here. Some more precise information about Guerrini's work as architect is contained in Bonamini's "Cronica della Città di Pesaro" (BOP, ms 966, p. 184):

> 1610 3 Agosto: Erano già stati eletti i deputati alla fabrica d'una nuova chiesa da dedicarsi a Sant'Ubaldo, vescovo di Gubbio, nell'anno 1605 in adempimento del voto fatto dalla nostra città, che si sarebbe fatta una nuova tempio[1] in onore di quel Santo, nella ricorrenza della cui festività fosse nata prole al nostro Signore, e siccome la nascita del Prencipe Federico accadde nella festa di S. Ubaldo, perciò in quest'anno Mons.r Vescovo Fra Bartolomeo fece la benedizione de' fondamenti e fu fabricata poi in seguito la chiesa di Sant'Ubaldo dalla Comunità nel presente luogo annesso al pubblico Palazzo, dove prima erano varie osterie e case del Sig.r Gio. Battista Monaldi da Pesaro, per quello lasciò scritto il Tontini nella sua Cronaca a <pagina> 121 presso il Zaconi, che ne possiede l'originale.
> Durò per molti anni tale fabrica e fu finita di coprire la cupola nell'anno 1618 il giorno 17 dicembre. Furono architetti di questa chiesa assai bene ideata un certo Guerini da Pesaro, come ho potuto riconoscere dai pubblici libri e M.ro Gio. Giacomo da Loreto insieme con M.ro Antonio da Fiorenzuola nostro castello. Il Tontini notò che nella cupola di Sant'Ubaldo furono impiegati 80 mila libre di piombo (lo cita a <pagina> 140).

A precious hint about Guerrini's activity as teacher of mechanics (and probably architecture) is constituted by a letter written to Clavius in 1607, some months after Guidobaldo's death.[2]
Further a "Francesco Guerini" is regularly nominated in the balance of the Community of Monte Baroccio, as recipient of "4 scudi":[3] sometimes, this payment

[1] tempio *ex* chiesa

[2] Cf. Chr. Clavius, *Corrispondenza*, critical edition by U. Baldini and P.D. Napolitani, cit.

[3] Cf. ACM, Libri del Consiglio, 1600-1622, fol. 97r; fol. 106r; fol. 111r. The fact, that this was a regular profession is testified by the balance of September 1602: "A Francesco Guerini per salario di sei mesi, sc. 4".

is specified by the addition of "per l'orologio". Given the connections of "our" Francesco Guerrini with Guidobaldo, it is plausible that these persons are identical.

Jacopo Mazzoni

Mazzoni's work *De triplici hominum vita* presents a division of all sciences in three *vitae*: the "active" one which comprises ethics, politics, economy and law; the "contemplative", divided in grammar, logics, dialectics, rhetoric, philosophy, mathematics, music, astrology, gnomonics, mechanics, physics and metaphysics, and also painting and sculpting; and the "religious" one, where Mazzoni examines also the non Christian religions and the various heresies of the Christianity, in order to confute them. "These three "ways" are illustrated by continuous references of a conspicuous number of ancient authors, which are brought in accordance in a symphony that placates the differences, particularly between the Platonic and Aristotelian philosophies, according to the ideal that there is already in Giovanni Pico.[1]
In the following, particularly important passages of the works are transcribed: the dedicatory letter with its references to the Urbinate cultural environment around Duke Francesco Maria II della Rovere and the dal Monte family; further, some of the chapter dedicated to fortification and mechanics in the wide sense.

> Candido Lectore:
> Qua quidem sola re (ut vera fatear) adeo perterrui, ut tunc tandem ingressus mihi viderer viam infinitam et impercursilem, cui nullo pacto fortuna mea sufficeret. Perrexi tamen Deo fretus, neque ille piissimus votis defuit. Namque fortunae coelum illud mihi prius densissimis nubibus nebulisque obtectum iisdem discussis atque disiectis Francisco Maria Metaurensium, amplissimo Duce, tanquam clarissimo sole me suavissime recreavit, qui cum in familiae suae obsequia me retulisset, deinceps omni genere magnificentiae, atque animi magnitudine in me fuit adeo liberalis, ut iam mihi res meae non modo supra spem, verum etiam supra vota succedere inciperent. Neque mirum is enim ille est princeps, qui modo cum paucissimis contra torrentem pessimorum morum brachia dirigit: proinde cum illi maxime liceret per fortunas et opes in luxu et delitiis vitam tranfigere, nihil tamen habet optimarum quarumque rerum scientia carius, nihil antiquius. Illud etiam in eius aula maximas mihi tulit suppetias, quod ibi licuit // Franciscum Panigarolam de facie cognoscere, aetate quidem adhuc parva: (...)
> Omitto praeterea quanta mihi hoc tempore sedulo, quanta officiose

[1] Cf. D. Dalmas, *Mazzoni Iacopo*, cit.: "Le tre vie sono illustrate con il continuo ricorso a un gran numero di autori antichi, fatti concordare in una sinfonia che ricompone le differenze, in particolare tra platonismo e aristotelismo, secondo l'ideale già di Giovanni Pico."

fecerit Rainerius e Marchionibus Montis totaque illius familia. Prae omnibus autem Franciscus Maria Rainerii filius, iuvenis omnibus fortunae, corporis, animique dotibus cumulatissimus, qui multis ab hinc annis quod vegetis, vigilantibusque oculis in studiis exploraverat mecum partiri consuevit, tot tantisque beneficiis est me persecutus, ut si iam id agendum sit, quod et bona nomina facere solent, quibus quando non est unde debitum reddant, saltem apud creditorem quantum debent profitentur, haec tota epistola, aliaeque permultae in hoc erunt consumendae. (...)

URBIS MUNITIO [fol. 85r]
(...) sed in monte ne, an magis in planitie debeat collocari civitas ut munitior sit adhuc ambigimus, in planitie namque minus bellicis hostium tormentis obnoxii sumus, scissurasque et cuneos minime reformidamus, maioremque copiam aquae possidebimus, bellicisque tormentis nostris hostes magis offendemus quam in monte, verum aggreribus hostium, machinisque bellicis, quas antiqui Helepoles vocarunt, turribus ambulatoriis, aliisque militaribus artificiis, quae murorum facilem praebent ascensionem magis subiicimur, demumque post oppugnationem fortior et valentior accedet inimicus in planitiae quam in monte. (...)

URBIS MURI EORUMQUE FORMA
Sed iam ad urbis muros eorumque formam **, et sane Vitruvius [MARGINE: I.I.c.4] collocanda existimat oppia non quadrata nec procurrentibus angulis, sed circuitionibus, ut hostis ex pluribus locis circumspiciuntur in quibus enim ex illius sententia anguli **, difficulter defenditur, quod angulus magis hostem ..., quam civem.
Ex qua re nonnulli audacter affirmarunt Romae circulos /fol. 87r/ a Romulo circulare factos fuisse, ideoque urbem ab orbe vocatam, cuius formam cum omnes imitarentur, propterea apud Italos omnes civitates urbes appellatas fuisse.
Verum labuntur isti, si Fabio pictori, Catoni, Cornelioque Tacito credimus,[MARG: I.2 in fragmentis I.12 Fest pom I.15. Var.4.d.I. lat. dixit foveam fuisse rotundam] hinc et illud Ennii: "Et quis extiterat Romae regnare quadratae" Et quid erit tandemsi et contrariam partem absque contradictione tueamur.
Turres quoque pro murorum defensione aedificandas esse existimavit Vitruvius, quorum intervalla essent talia, ut ne longior sit alia ab alia sagittae emissione, ut a turribus murorum oppugnatores telorum emissionibus reiiciantur. Easque rotundas vel polygonias exoptavit, cum quadratae machinis facilius dissipari putaret. Vegetius [MARG. I.4.c.2] vero ex altera parte secus existimasse videtur, qui sinuosis an-

fractibus iactis fundamentis urbes claudi crebrioresque turres in ipsis angulis effici debere arbitratus est, propterea quod si quis ad murum, vel scalas, vel aliud quid admovere velit, non solum a fronte: verum etiam a lateribus et a tergo pene, veluti in sinum conclusus opprimitur. Quod et Cornelio Tacito minime displicet. [MARG. I. 21 in solimae descriptione]

Quod autem inquit Vitruvius urbes rotundas esse debere si prorsus rotundas intelligit ratione caret, difficillime namque turres licet crebrae muros tueri poterunt. Quod si rotundas uti polygonias accepit, optime docet. Nec ab eo dissentit forsan Vegetius.

Turres quoque rotundas Vitruvius, Leo Baptista, Durerusque [Ariss. prol. 9. sec. 19.] summe laudarunt, quod et eo magis probari potest, quo magis etiam saepius hanc formam sectatur natura, non attamen (et in his praecipue tempribus) sunt ab architectis optandae cum totae prorsus defendi nequeant. (...)

Quod si belloardua [BIS: atque] anguli acuta erunt [per 28. prop primi Euclidi], murorum et belloarduorum extremae lineae aequales erunt et propterea nunquam simul concurrent, quomodo igitur tormentorum glandes tota tutabuntur belloardua? Quod si recta vel obtusa sint minus etiam defendi poterunt, si quidem tum extrema belloarduorum linea infinite protracta magis magisque a muri recedet. Haec vero licet ita se habeant, reperiemus tamen nos figuram, quae belloarduorum latera, licet maiora, quam angulos facile tutari possit, quod quidem praestabimus si muros ita deducemus, ut in belloarduorum medio, campos versus angulum efficiant obtusum cuius quidem figuram hic apponimus.

Et in hac sane figura duo fere admirabilia eveniunt, si quidem in primis secus evenit, ac existimarit Nicolaus Tartalea excellens mathematicus, contraria enim forma et solo duorum tormentorum ictu totam murorum superficiem defendimus, cum in aliis fere omnibus hoc fieri nequeat, quandoquidem icus semel ad invicem secant, ne secus belloardua similiaque glandibus pulsentur ad invicem.

Quod si huic formae muros concameratos addamus quales Albertus Durerus existimavit [MARG Albe. Dur. in suo lib. de muniendis urbibus], adeo tamen ut in media fornicatione, quoddam appareat adminiculum, tum ad fulciendum mutum, tum ad sustinendas lapides alto /fol. 88r/ delapsas, urbem ni fallor egregie muniemus. (...)

URBIS PORTAE

Fiant autem portae in angulo ipso, qui est inter belloardua [Leo Bapt. in lib. 9], cum enim et apud architectos constet portas tanquam os, belloardua vero sicut oculos esse, optime se tum res habebit, cum duobus belloarduis unam assignabimus portam. (.....)

ORDO <di una battaglia navale>
Publico autem Marte tiburnarum acies non directae ut in campo instituebantur, sed incurvae ad lunae similitudinem, ita ut productis cornibus acies media sinuaretur /fol. 105r/ ut si adversarii prorumpere tentassent, ipsa ordinatione circundati deprimentur. Contra hanc demum ita ut adversus cuneum cavum terrestrem, triplex phalanx consituta est, qua modo recteque usa est classis christiana contra turcas in Naupactea victoria, cui nullam neque antiquam neque recentem aequabimus. Et p ropterea qumnam alium Imperatorem, Serenissimo Ioanni Austrio comparabimus.

The following excerpts of letters testify the attention that was paid to Mazzoni's work in Guidobaldo's environment: so, Fabio Albergati wrote to Pier Matteo Giordani:[1]

> L'opra del Mazzone non è ancora stata veduta qui, se V.S. l'ha letta mi farà gratia a scrivermi liberamente il suo parere.

Also Baldi wrote to Pier Matteo Giordani in this regard:[2]

> De' libri del S.r Mazzoni poche se ne veggono et egli me ne promise uno, ma distratto da negotii maggiori non me lo diede qua. Non ho udito che i letterati si meraviglino punto ch'egli faccia Aristotile sprezzarne delle matematiche, né io mi maravigi del loro non meravigliarsi poiché in Roma tutta data ad altri studii le matematiche se ne stanno dormendo.
> Comminciai a godere della conversation del S. Mazzoni et alcuna volta ha [disinato col] S. Card.e S. Giorgio et ha mostrato ad uso di [Dinnosofista] la bellezza del suo ingegno. Io gli mostrai una epitome delle vite de Matematici la quale m'affermò che gli piacque. L'occasione della partita del S. Card.le Aldobrandino ha rotto il nostro con*** avendolo condotto seco nella Marca e fra a quest'ora so che V.S. l'averà veduto in Pesaro ove si potrà meglio chiarire de dubbii di che mi scrive. Avrà saputo anco da lui che egli con molto applauso ha ottenuto la lettione di Filosofia ordinaria nella Sapienza con provisione di mille scudi l'anno con la quale egli può dar delle [mentile] al Petrarca ove dice "Povera e nuda vai filosofia". Ma del S. Mazzoni s'è ragionato anzi per una lettera e picute a quello che merita."

Further, Baldi introduced Mazzoni as his interlocutor in the work *Il Tasso ovvero della Nautra del verso volgare italiano* (1592). This, too, proves the impact, that Mazzoni had left in his Urbinate phase.
Also Guidobaldo's letters to Galileo contain some references to Mazzoni and express Guidobaldo's envy not to be able to discuss with both of them at Pisa.

[1] Cf. BOP, ms 402; fol. 28r; September 24the 1597.
[2] Cf. BOP, ms 430 fols. 29r-30v, December 16th 1597.

Mazzoni dedicated a little treatise on diphthongs, composed in 1571 and printed in 1572, exactly to Francesco Maria dal Monte.[1]
For its dedicatory letter, cf chapter I.3.

> Da carta 14v segue una parentesi matematica: Mazzoni sostiene questo: "Ora, inanzi ch'alla vulgar lingua valichiamo nella quale vi sono molte cose per se stesse da considerarsi, sia meglio il raccolgiere quanto fin'ora s'è detto, e mostrare la necessità de dittongi nella graca e nella latina lingua. E' dunque il concorso accidentale quello che per la colisione ha solamente un suono semplice e una sillaba sola per lo più: perché se bene alle volte questo concorso esce di quella natura, come di sopra mostramo. Questo è solamente per accidente, e non secondo il solito, se per accidente è quello che nelle cose che di rado accagiono ha luogo e seggio, che sempre si suol cacciar dall'universal consideratione d'ogni artefice scientifico, e così il naturale è quello c'ha due suoni, e due sillabe distinte, ancoraché per l'accoppiamento si parta dal suo solti quando che sia. E donque il concorso naturale doppio, e l'accidentale semplice, siché se vogliamo sapere quai sieno quei semplici e quei doppii, ch'a mezo di loro danno luogo ad altro. Ritrovaremo s'io non m'inganno l'introduttion de' dittongi poiché egli (come più di sotto proveremo) non è altro ch'un mezo fra'l naturale e l'accidental concorso, e però da noi sarà chiamato concorso artificiale. Il doppio poi in molte maniere si può considerare, peròché o gli è primo o secondo: primo è quello che nasce dal numero lineare come in questa figura si vede
>
> 1 2
> Secondo è quell'altro che dagli altri numeri o corporei o superficiali che si sieno ha l'origine, come questi
> 2 4
> 3 6
> 4 8
>
> E per porre ogni cosa inanzi agli occhi, a guisa d'Aristotele e di Platone dalle Mathematiche pigliaremo sensato essempio, sia dunque un numero doppio all'altro nella seconda maniera, come 8 a 4 overamente 3 a 6. Nei quali è manifesto esser proportion geometrica di ragion doppia. Dico allora ch'in mezo a questa proportione è necessario che vi sia mezo, o la sesquialtera o la sesquiterza od'una insomma delle proportioni sopra particolare, o una delle soprapartienti che vi ponno

[1]The title is J. Mazzoni, *Discorsi de' dittongi*. It comprises 30 folia, divided in three parts (*particelle*): "Dove si discorre dell'invention de' dittongi" (cc.5r-7r), "Dove si discorre della causa ch'ammesse i dittongi nelle lingue" (cc.7v-26r) e "Dove si discorre della pronuncia anticha de dittongi" (26v-30r).

cadere, e questo adiviene perché noi non potiamo far passaggio da una estremo all'altro senza mezo (...).

[fol. 17r] Ora tra questi crivelati mezi facendo tra essi comparatione brevemente investighiamo, e sciegliamo il più proprio di loro, e accioché alla nostra investigatione possiamo avere un picciolo calle ci bisogna gittar prima fuori della seva gli arbori attraversati e le spine, e primieramente diremo, che'l mezo nel quale si dee porre il dittongo fra'l concorso naturale e l'accidentale, non è per geometrica proportione, né per aritmetica, poiché in questi due non ci moviamo dai puri termini della quantità per venire o a diversi predicamente, o al medesimo, ma capace di contrarietà: non è ancora mezo per quantità continua, poich'egli sta nei suoni e nelle sillabe che dalla quantità separata sono compresi, non è medesimamente mezo per negatione degli estremi poiché non diciamo il dittongo esser quello che non ha suono o sillaba semplice o doppia, ma quello che ha due suoni e una sillaba. Resta dunque ch'egli sia mezo per participatione, non di quella c'ha gli estremi contrarii, poiché suono a suono e sillaba a sillaba non è contraria: ma di quella c'ha negli estremi diverse cose, come in quelli del dittongo si scorge, che sono sillaba e suono: però il concorso accidentale sendo d'un suono e d'una sillaba, il naturale di due suoni e di due sillabe hanno in mezo dato luogo al dittongo il quale poiché non patisse collisione ne si proferisce in due sillabe, però sia o di due sillabe o d'una suono o d'una sillaba e di due suoni. (...)

The Pucci family

Some information about the Pucci family is a short description conserved at the Biblioteca Universitaria Urbino:[1]

> Non si trova alcun'altra giustificazione per giovare la Nobiltà della Famiglia Pucci, oltre l'anno 1586 in cui Agostino Pucci fu Gonfaloniero.
> (..)
> <Fortuniano Pucci, padre di Barbaro Pucci,> "fu Capitano di Milizia nella nostra città (...). Inoltre Giuseppe Pucci, fratello maggiore di Fortuniano Pucci, fu Gonfaloniero; e lo stesso Fortuniano prese in consorte Vittoria Felice Giorgi d'Urbino di famiglia nobile.

A hint at the connection between Guidobaldo and Cesare Pucci is contained in a letter from Fabio Barigiani to Giulio Giordani:[2]

[1] Cf. BUU, Fondo del Comune, Busta 173, fols. 5ff.
[2] Cf. BOP, ms 425, fol. 196r/v.

Molto m.co S.r mio oss.mo
A ms. Cesare Pucci ha detto Antonio Nanni che sa da persona che lo può sapere che fra S.A. et il S.r Alfonso <Piccolomini?> passano lettere amorevolissime; il S.r Guidobaldo che l'ha inteso da ms. Cesare l'ha riferito a ms. Pier Matteo <Giordani>, et io l'ho inteso da lui.
(...)
Bacio la mano di V.S., pregandoLe da Dio ogni bene. Di Pesaro a 15 di luglio dell'84.
Ser.re Fabio Barignani

Nicolò Sabbatini

Bonamini exposes in his *Abecedario degli architetti pesaresi* (BOP, ms 1009) the following description about Guerrini (pp. 89-91):[1]

1630 Sabattini Nicolò
Il Quadrio, non so per qual ragione, chiama Nicolò Sabattini da Ravenna e non da Pesaro. Forse è stato cagione di questo l'essere il di lui padre Appollinare Sabattini originario di Ravenna e primo abitante pesarese. Del figlio non v'ha dubbio che a noi appartenga, avendolo egli stesso confessato con intitolarsi da Pesaro.
Godé costui l'onore ed il bel vantaggio d'essere buon discepolo del nostro Archimede d'Italia, illustrissimo Signor Guidubaldo de' Marchesi del Monte. Quanto egli s'approfittasse d'un tanto maestro ne fanno fede le sue opere, il nostro Teatro del Sole ed i molti manoscritti che lasciò di pratica d'architettura civile e militare, scritti e delineati dalla di lui penna per non istarsene oziosa sopra tutte le materie di matematiche.
Egli per tutto lo spazio della sua vita fu architetto de' serenissimi duchi d'Urbino, ed il Macci così di lui discorre nel capitolo X del libro II: "Sabbatinus et nomine et dignitate iis omnibus, quos prisca aetas summopere admirata fuit, omni ratione et numero est preferendus; eoque maior et dici et haberi debet, quo (Francisco Mariae II) principi sapientissimo atque omnibus numeris absolutissimo in gravissimis operum maxiomorum negotiis iugiter inservit".
Infatti non si fece fabbrica di considerazione nello stato dei serenissimi nostri signori senza il suo consiglio. In Pesaro fece il porto, di cui parlò il Macci nel citato luogo, construsse l'appartamento nobile detto di Madama nella corte di Pesaro, ch'è quello sopra i fondaci. In Sant'Angelo in Vado fabbricò da fondamenti la casa in villa detta

[1]The manuscript is transcribed and published in D. Bonamini, *Abecedario degli architetti e pittori pesaresi*, ed. by G. Patrignani, in âPesaro città e contà", VI (1996).

la Palazzina per servizio di quelle altezze. Ne' teatri si rese insigne architetto, mentre non solo operò mirabilmente nel nostro Teatro del Sole, ma anche stampò la *Pratica di far le scene*, data in luce nell'anno 1638 per le stampe di Pietro de' Paoli e Giovan Battista Giovanelli in Ravenna in foglio libro primo e secondo, giacché in Pesaro nel 1637 per Flaminio Concordia non si era stampato se non che il primo libro. Dall'ultimo capitolo 57 di quest'opera siamo eruditi che Nicolò Sabatini in gran parte praticò le machine di cui ebbe discorso ne suoi libri, in ocasione che da quei gentiluomini con apparato di sontuosi intermedi si rapresentò l'*Asmondo*, tragedia del signor Giovanni Ondedei nobile di detta città: " Tali spettacoli, rappresentati in Pesaro nel Teatro del Sole eretto l'anno passato, riuscirono così felicemente ch'hanno apportato particolare ammirazione e diletto ai riguardanti". Da questo passo sembra che l'epoca del nostro teatro debba fissarsi all'anno 1637.
Fino a qual'anno vivesse Nicolò Sabbattini non è a mia notizia. Può ben assicurarsi che nell'anno 1638 fosse vivo, dicendo lo stampatore al lettore che sperava di disporre l'autore a participare l-altre sue pratiche d'architettura civile e militare, come leggesi c. pag. 11.
Nell'indice de' manoscritti esistenti [nella] libreria Olivieri vedesi, sotto il numero 312, *Machine da teatri* di Nicola Sabatini da Pesaro, in quarto. Di questo eccellente sogetto parlò l'Olivivieri nella sua opera *Del porto di Pesaro*, c. 62, ed anche il Macci in altro luogo così: "Constituit Nicolaum Sabbatinum patricium pisaurensem architectum peritissimum ac virum in aedificiis construendis ac maximis molibus dirigendis versatissimum" etc.

Count Giulio da Thiene

Information about the life of Count Giulio da Thiene is contained in BOP, ms 1063, tomo II, fol. 128r/v:

Vicentina è la famiglia nobilissima Thiene, dalla quale escì Gaetano che Santo sì adora sugl'altari. Pure un qualche ramo di questi Thiene convien dire sia stato in Pesaro, anzi il ramo stesso di questo Conte Giulio che credo il primo venisse ad abitarvi. Ecco l'albero ch'io mi trovo avere di tale famiglia pesarese: [figura di un albero di famiglia] Dal primo Conte Giulio fece onorata menzione il nostro Lodovico Agostini nel principio della sua VI giornata soriana scrivendo così "Il Conte Gioan Giacomo Leonardi di Montelabate, il Muzio Giustinopolitani ed il Conte Giulio Thieni, tre Monarchi di Scienze." Anche il nostro D. Giulio Tortorini nelle Memorie di Pesaro, dove fa brevissima menzione di pochi uomini che si segnalarono nelle scienze e

nell'armi, chiama il Conte Giulio Thiene Architetto celebratissimo, figlio del Conte Clemente, nominato dal Tortorini per primo abitatore di Pesaro. E' da osservarsi che tra le lettere di Fabrizio Ondedei molte se ne trovano dirette a Vicenza al Conte Giulio Thiene ch'io reputo il secondo, e non quello, di cui ora facciamo parola, vissuto dopo la metà del secolo XVI. L'adotto arbore genealogico spiega a meraviglia la piccola confuzione, che potrebbe nascere dalla somiglianza dei nomi di quei due Signori. //
Le lettere dirette al secondo Conte Giulio Tieni dall'Ondedei sono cinque, pagina 15, 47, 54, 59, 65. Dalla prima diretta a Pesaro si conosce che il Thieni era amante ed applicato alla lodevole lezione dell'Historia. Dalla seconda che dovea portarsi contro Barbari congiurati alla rovina d'Italia e questa fu scritta a Vicenza; altra scrisse Fabrizio da Venezia a Verona, ed allor ail Thieni non era ancora andato in Campo, e le altre due gli furono dirette a Venezia.
Dalla notizia datane da nostro Si.r Calsito Marini archivista in Roma al Sig.r Annibale Olivieri di buona memoria si viene in cognizione che del primo Conte Giulio Thiene chiamato dall'Agostino come sopra notai "monarca di Scienza esiste nella Biblioteca Vaticana Urbinate il Codice seg.o 284 che ha per titolo "Iulii a Tiene opus de re militari ad Franciscum Mariam Urbini Ducem". Nel tesoro politico Tomo III, pagina 222 leggl che dall'entrate della Città di Urbino, il Duca Francesco Maria II avea assenato scudi 2000 al Sig.r Conte. Giulio da Tiene.

Count Giulio da Tiene was in contact also with Federico Bonaventura. With the following letter, the former asked the philosopher to borrow him a mathematical instrument, required for his activities as architect:[1]

(...) Ho avuto il labacco et La ringratio, et quando Ella per disgratia sarà Architettore, Glielo restituirò, et non prima, ma ci vuole tempo et copia. In questo mezo, se V.S. ha [nisuna] carta stampata di figure o d'altro, me ne accomodi non essendo per ora professione Sua. (...)
Ho fatto scrivere per ms. Don Federico Donati a ms. Girolamo Genga come per conto del Sig.r Alfonso Picc<olomi>ni; il Podestà non li darà fastidii, ma che mandi a me una supplica che si farà signare per la quale adimandi gratia di tal caso et intanto dia sicurtà di supplicare. Bisognerà anco una supplica per conto del caso che sucesse col [Rossino]: egli a me avisa di mandarmi una supplica, ma io non l'ho avuta. Detto ms. Girolamo ha in un camerino non so quante carte stampate di vasi antichi, desidero che V.S. si contenti fargliele adimandare a nome mio, che son certo me le darà come adimando

[1](cf. BUU, Fondo del Comune, Busta 93, fols. 161r-162r, 28 (?) novembre 1579 (?).

anche a ms Aurelio [nostro] col mezo di V.S. avendole Ella, come stimo, piacciaLe di mandarmele. Son chiamato da Sua Ecc.za a Caccia, BascioLe le mani. A 28 (?) di novembre 1579 (?) di Pesaro Di V.S. Ser.re Giulio da Thiene.

The following letter is a testimony of Thiene's activity as diplomat:[1]

Ill.mo et Ecc.mo S.re et mio Patron sempre osser.mo
Giunto in Vinegia, il terzo giorno ebbi gratissima udienza in colegio dal Sereniss.o Prencipe con tutta la Ill.ma S.ria et fui fatto sedere alla destra di detto Sereniss.o et fummi dal medesimo data amorevolissima risposta et piena di affettione verso V.Ecc.za, mostrando molta alegrezza et satisfattione del parentado seguito con Madama Lucrezia da Este. Et mi hanno fatto nel colegio molto onore, perché il Serenissimo Prencipe con tutta la Sig.ria si levorono tutti in piede, et il simile fecero nel partirmi, stando così sempre, fino all'uscire che io feci dalla porta del colegio.
Domatina tornarò nel medesimo luogo per licentiarmi, come mi hanno promesso, et cercarò di ispedirmi per potere venire ad incontrare il S.or Prencipe Ill.mo avanti che giugno a Ferrara.
Ho visitato tutti gli ambasciatori, et il legato di Sua S.tà et molti gentiuomini,e t tutti hanno mostrata molta contentezza del parentado, et ho scoperto, per quanto a me è parso, una affettione grandissima verso V. Ecc.za in pubblico et in privato, come al mio ritorno meglio racconterò a v. Ecc.za.
La cosa del Duca di Fiorenza qua è stata molto male intesa, et lasciano ritornare il suo ambasciatore senza risposta in iscritto. Ha avuto dal Sereniss.o Prencipe li tittoli ordinarii di Ill.mo et Ecc.mo et molte carezze, et una colana d'orao di 300 scudi. Il S.r Duca di Ferrara ha fatto il medesimo, però che // come vedrà li tittoli che gli darà l'Imperatore che allora poi si risolverà.
Si è mostrato il Cap.o dell'Investitura di V. Ecc.za del magno et massimo, et è molto piacciuto et stato grato a tutti et fra gli altri il legato del Papa mi disse che in detto capitolo ci era cosa di maggiore importanza che di magno et maximo.
Io pregandolo a volerlo dire, rispose che io non l'agrvasse in questo però V. Ecc.za potrà far considerare Lei. Bascio la mano di V. Ecc.za in Sua buona gratia raccomandomi, pregando il S.re che La facci contenta. A 7 di genaio MDLXX di Vinegia.

[P.S.] L'ambasciatore dell'Imperatore et quello del Re di Francia mi hanno adimandato se V. Ecc.za ha fatto dar conto del parentado a

[1]Cf. ASF, Ducato di Urbino, Classe I, 217; fol. 897r/v.

quelle M.tà. Ho risposto che penso che Ella lo abbi fatto. Di V. Ill.ma et Ecc.ma S.ria
Affett.mo et oblig.mo ser.re
Giulio de Thiene

The next two letters testify that Giulio da Thiene was involved in the process of controlling the mechanical clocks, fabricated at Pesaro and Urbino:Cf. ASF, Ducato di Urbino, Classe I, 217; fol. 902 r; October 28th 1585, Giulio da Thiene to Giulio Veterani.

Molto mag.co Sig.r mio oss.mo
Io sono in Venetia et in viaggio per tornarmene a Pesaro a servire Sua Altezza come è l'obligo et desiderio mio sempre. Ma perché il Sig.r Marchese di Carara mi ha scritto a Vicenza, come ha anco fatto il Conte Giulio Thiene di Scandiano, et come mostrerò al mio arrivo di Pesaro a V.S. che desiderano di parlarmi, et particolarmente il Sig.r Marchese per particolar suo negotio, et avendo trovato qui in Venetia un suo gentiluomo che mi ha aggravato del medesimo, et oltre acciò oggi ho avute nuove lettere del medesimo S.r Marchese che mi fanno la medesima instanza di desiderare di parlar con me a Medelana, luogo del detto Sig.r Marchese, mi sono risoluto per questo fare quella via, essendo Medelana luogo traposto tra Rovigo et Argenta, et il tutto ho voluto conferire col S.r giuliano [Ugostone].
Mi è parso dunque dare aviso a V.s. della risolutione mia di passare per quella strada sotto Ferrara, parendomi essere sempre bene l'intendere. Et del tutto darò conto come io sia a Pesaro. Piaccia dunque a V.S. far sapere il tutto a Sua Alt. Ser.ma a nome mio, soggiugnendo che fra tre o quattro giorni sarò in viaggio.
Potrò anco dire a Sua Alt.a che m.<astr>o Gherardo Orloggiero mi ha detto avere l'orologgio da tavola di Sua Alt.a per cunciarlo et che avendo io presso me la nota de' difetti che a quel tempo aveva detto orologgio, che sarò seco acciò dia rimedio a quanto bisognarà. Bascio la mano di V.S. et di cuore me Le raccomando. A 28 di Xbre 1585 di Venetia.
Di V. Sig.ria Ser.re Affett.ma sempre
Giulio da Thiene

In this context, also the following letter is interesting:[1]

Ill.mo et Ecc.mo Sig.r mio Patron sempre oss.mo
Fino ad ora non si è potuto cominciare a lavorare gli orloggi per non

[1]Cf. F. Lampertico, *Di Giulio Thiene. Uomo d'arme e di scienza del secolo XVI*, "Atti del reale Istituto veneto di Scienze, Lettere ed Arti", XXXVIII 7 2 (1890-91); pp. 923-982.

> ci essere stata commodità di tavole per l'armature, né di calce al proposito per lo stucco dove vanno lineati; ma domani che è lunedì il proveditore mi ha detto che me ne accommoderà et si attenderà continuamente a lavorare. Et perché si hanno a fare le tre sorte di orloggi, dal tramontare del sole, dal levare, e dal mezogiorno, mi era venuto in pensiero di farne anco due altri dell'ore inequali, il quale divide ogni quantità di giorni in dodici parti che è utile per sapere ogni giorno quanta parte del giorno sia passata; et per essere maniera di orloggio antichissimo et acciò che ve ne siano lineati di ogni sorte nel cortile, aspetto però risposta da V.S. Ill.ma di quanto Le parerà ch'io facci. Bascio la mano di V.E. Ill.ma in suo buon gratia, racc.mi pregando il Signore che La prosperi tuttavia. A 29 di maggio MDLXXIV di Pesaro,
> Di V. Ill.ma et Ecc.ma Sig.ria
> Aff.mo et obblig.mo serv.re
> Giulio da Thiene

Interesting information about the relation between Guidobaldo and Giulio da Thiene is contained in L. Agostini's *Giornate Soriane*:[1] apparently, Guidobaldo's mother was a friend of Maddalena Thiene, member of Giulio da Thiene's family and wife of count Carlo Ubaldini. In fact, at the third day (*Giornata III*), they are described to be in company, in the middle of other acquaintances and friends of Guidobaldo:

> [42] Non avevamo ben caminato venticinque passi che trovavamo i Baregnani, signori della villa dov'andar volevamo, gli eccellenti Fabio, Zoroastro et Alessandro (...) che erano venuti ad incontrarci con alcune donne, che con le loro avevano: erano queste la contessa Minerva Pianosi de' Marchesi del Monte, la contessa Maddalena Thieni Ubaldini e madonne Ippolita Leonarda Barignana, Beatrice Giordana Veterana, Madalena Giordana Barignani (...).

[1] Cf. L.S. Firpo *Ludovico Agostini. Le Giornate Soriane*, Roma, Salerno, 2004. The following references and units of the text refer to this edition.

The End

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